United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

IN REPLY REFER TO:
1-1-00-F-0054

November 4, 2002

Kathleen M. Goforth, Life Scientist
CWA Standards and Permits Office
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Dear Ms. Goforth:

This is in response to the U.S. Environmental Protection Agency's (EPA) February 8, 2000 letter to the U.S. Fish and Wildlife Service's (Service) requesting formal consultation pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). This letter was received by the Service's Sacramento Fish and Wildlife Office (SFWO) on February 16, 2000. The request for consultation stemmed from the EPA's proposed approval of two amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan). The two amendments are part of a set of amendments (Grassland Amendments) adopted by the California Regional Water Quality Control Board - Central Valley Region concerning regulation of agricultural subsurface drainage discharges from the Grassland Watershed of Merced and Fresno Counties. The EPA has determined that its approval of these two specific Grassland Amendments is likely to adversely affect the giant garter snake (*Thamnophis gigas*), federally listed as threatened (T).

The EPA also determined that its approval of these same two Grassland Amendments may affect, but is not likely to adversely affect the bald eagle (*Haliaeetus leucocephalus*) (T). In addition, the EPA determined that its approval of certain related Grassland Amendments may affect, but is not likely to adversely affect the Aleutian Canada goose (*Branta canadensis leucoparia*) (formerly threatened; recently de-listed), bald eagle (*Haliaeetus leucocephalus*), giant garter snake (*Thamnophis gigas*), delta smelt (*Hypomesus transpacificus*) (T), and Sacramento splittail (*Pogonichthys macrolepidotus*) (T). In its February 8, 2000, request for formal consultation, the EPA requested Service concurrence with these determinations.

The Service concurs that EPA approval of the two specifically identified Grassland Amendments may affect, but is not likely to adversely affect the bald eagle. However, we disagree with the EPA's determination of 'no affect'on the Sacramento splittail for these same two amendments. The

EPA's request for formal consultation only considered effects of the Grassland Amendments approval on the giant garter snake, based on the agency's determination that the listed species noted above, including the Sacramento splittail, do not occur within the Grassland watershed. However, numerous Sacramento splittail specimens were collected in the watershed (Mud Slough and Salt Slough) in 1998 (Beckon *et al.*, 1999). Based upon these documented occurrences in the project area, formal consultation must include effects of the action on this species.

Regarding the EPA's determinations on the related Grassland Amendments, the Service concurs that EPA approval may affect, but is not likely to adversely affect the Aleutian Canada goose, bald eagle, delta smelt, giant garter snake, and Sacramento splittail. However, for one of these related Amendments (see 'Description of Proposed Action' section), Service concurrence is predicated on the fulfillment of EPA commitments and obligations involving the revision and promulgation of water quality criteria for selenium that are protective of listed species. These commitments resulted from formal section 7 consultation on the EPA's approval of the California Toxics Rule (CTR). Discussion of the CTR pertaining to the Grassland Amendments is presented in the 'Effects of the Proposed Action' section of this biological opinion.

The Service agrees with the EPA's determination of 'no effect' for eight upland or vernal pool species in the project area. This determination was based on the EPA's finding that these species are not, at any point in their development or foraging ecology, dependent on the aquatic ecosystem, or would not be adversely affected by selenium at the concentrations proposed in the Grassland Amendments (e.g., plants and invertebrates). The eight species not likely to be affected by this project are: giant kangaroo rat (*Dipodomys ingens*) (federally listed as endangered: E), Fresno kangaroo rat (*Dipodomys nitratoides exilis*) (E), San Joaquin kit fox (*Vulpes macrotis mutica*) (E), mountain plover (*Charadrius montanus*) (proposed for Federal listing as threatened: PT), blunt-nosed leopard lizard (*Gambelia (=Crotaphytus) sila*) (E), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (T), Colusa grass (*Neostapfia colusana*) (T), and Hoover's woolly-star (*Eriastrum hooveri*) (T; proposed for de-listing). Because of the 'no effect' determination, these species are not considered further in this biological opinion.

Listed species that are isolated from, do not forage directly in, or are not present in the affected area but were discussed in the EPA's biological evaluation prepared for this project include: riparian woodrat (*Neotoma fuscipes riparia*) (E), riparian brush rabbit (*Sylvilagus bachmani riparius*) (E), Aleutian Canada goose (*Branta canadensis leucoparia*) (now de-listed), California red-legged frog (*Rana aurora draytonii*) (T), California tiger salamander (*Ambystoma californiense*) (candidate for listing), longhorn fairy shrimp (*Branchinecta longiantenna*) (E), vernal pool tadpole shrimp (*Lepidurus packardi*) (E), and vernal pool fairy shrimp (*Branchinecta lynchi*) (T). These species are considered not likely to be affected by the proposed action and are not considered further in this biological opinion. Therefore, unless new information reveals effects of the proposed action that may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the ESA is necessary for the species listed above.

This biological opinion is based upon information and/or commitments provided in:

1) The October, 1988 Amendments to Water Quality Control Plan for the San Joaquin Basin (5C) for the Control of Agricultural Subsurface Drainage (Draft Report),

2) The November 28, 1988 letter from George Nokes, Regional Manager, California Department of Fish and Game (CDFG),

3) The January 1994 Total Maximum Monthly Load Model for the San Joaquin River (Staff Report),

4) The October, 1994 Draft Agricultural Drainage Options Plan by California State Polytechnic University,

5) The June 1995 Beneficial Uses Designations and Water Quality Criteria to be Used for the Regulation of Agricultural Subsurface Drainage Discharges in the San Joaquin Basin (5C) (Staff Report),

6) The August 1995 Water Quality Objectives and Implementation Plan to be Used for the Regulation of Agricultural Subsurface Drainage Discharges in the San Joaquin River Basin,

7) The September 11, 1995 Comments on Staff Report from the California Regional Water Quality Control Board-Central Valley Region,

8) The November 1995 Compliance Time Schedule to be Used for the Regulation of Agricultural Subsurface Drainage Discharges in the San Joaquin River Basin,

9) The March, 1996 Amendments to Water Quality Control Plan for the San Joaquin Basin for the Control of Agricultural Subsurface Drainage Discharges (Draft Staff Report and Draft Executive Summary),

10) The July 27, 1997 Real-time Quality Management of Wetland Discharges to the San Joaquin River,

11) The March 1998 Response to Comments on the Tentative Waste Discharge Requirements,

12) The July 24, 1998 Minutes, Regional Water Quality Control Board Meeting,

13) The August 1998 Waste Discharge Requirements for the San Luis & Delta-Mendota Water Authority,

14) The February 2000 Biological Evaluation of the Grasslands Amendments from EPA,

15) The March 24, 2000 Final Biological Opinion on the California Toxics Rule (Service File No. 1-1-98-F-21),

16) The May 24, 2000 EPA letter to the State Water Resources Control Board approving the Grassland Amendments, subject to the results of consultation under section 7 of the ESA,

17) The September 6, 2001 EPA letter to the Service and the National Marine Fisheries Service (NMFS) proposing changes to the terms and conditions outlined in the March 24, 2000 Final Biological Opinion on the California Toxics Rule, and

18) information in our files.

A complete administrative record of this consultation is on file in the SFWO.

Consultation History:

Through phone conversations and e-mail correspondence in early 1996, the Service and EPA Region IX opened a dialogue on the EPA's need to consult on the many California Regional Water Quality Control Board (Regional Board) basin plans currently scheduled for EPA approval. Discussions revolved around names of contacts and coordination with the several Service field offices that would need to be involved with the consultation, the development of a matrix with individual basins and issues listed with EPA draft 'affect' determinations.

In an April 8, 1996, letter the EPA requested informal consultation on its actions to approve all or part of 13 Regional Board and tribal basin plans. Enclosed with the letter were copies of individual basin plans and a matrix identifying issues and preliminary 'affect' determinations. The EPA requested concurrence on 'affect' determinations for issues regarding lack of numeric criteria, omission of appropriate beneficial uses, and terrestrial species.

On August 29, 1996, the SFWO provided updated species lists for California and concurred with the EPA's April 8, 1996, conclusion that lack of some beneficial use designations for basins 4, 5A-C and 5D would result in a determination of 'likely to adversely affect' for listed species. However, the Service pointed out other basin plans that lacked appropriate beneficial use designations for waters occupied by listed species and that the Service could not concur with EPA's 'not likely to adversely affect' determination on those basin plans. With regard to the EPA's determination of 'no effect' for terrestrial species, the Service could not concur at that time because many of the terrestrial species are highly aquatic dependent and additional information would be required to assess effects. The Service concurred with the EPA that the lack of numeric criteria for basin plans 2, 5A-C, and 8 would result in a finding of 'likely to adversely affect.'

On March 20 1997, the EPA reinitiated informal consultation on the California Toxics Rule (CTR). The CTR is directly relevant to numeric criteria in basin plans because those criteria proposed by the EPA in the CTR would likely be amended into basin plans. Both agencies were in agreement that consultation on the CTR was a higher priority, and discussions regarding basin plans were put on hold until the CTR was near completion.

On May 5, 1999 both the Service and NMFS (collectively 'the Services') met with the EPA. At that time informal consultations on the basin plans were reinitiated. The group discussed timelines, individual basin plan amendments, and mutually identified issues. There was confusion between the EPA and the Services about whether consultation was on entire basin plans, parts of basin plans, or only the recent basin plan amendments. The EPA explained that a basin plan included items required under federal and state laws and regulations, and that only those portions that were federal activities could be consulted on by the agencies. Individual basin plan amendments that had yet to be approved were given priority by the EPA.

A meeting with EPA and the Services was held on June 7, 1999 to specifically discuss the North Coast basin plan consultation. Similar issues and concerns across basins led to discussions on other basin plan amendments, including the Grassland Amendments.

A June 23, 1999, meeting with EPA and the Services was held to discuss general consultation issues regarding basin plans, specific issues with individual plans, and how to address basin plan issues not associated with amendments but under EPA authority and which had yet to go through ESA consultation. The Service staff felt that although the EPA was only acting on approval of individual amendments, to properly evaluate them under the ESA we would have to evaluate the entire basin plan to put the amendments into proper context. The EPA stressed that the consultations should only be on the federal actions that they were taking at the time, which were only the approvals (all or part) of the basin plan amendments. It was suggested that individual basin plan amendments that had yet to be approved by the EPA be given priority; however, other basin plan issues regarding listed species could be provided to the EPA as recommendations to include in their approval letter to Regional Boards. As the Regional Boards addressed these issues in future triennial reviews and amendments, the EPA would consult with the Services.

On July 2, 1999, a species list for the Grassland Amendments was requested by EPA and on July 12, 1999 an updated species list was provided by the SFWO.

A December 10, 1999, EPA e-mail provided the Service with a draft biological evaluation for the Grassland Amendments.

A February 8, 2000, letter from the EPA to the Service requested initiation of formal consultation under the ESA and included a final biological evaluation for the Grassland Amendments.

BIOLOGICAL OPINION

Description of the Proposed Action

Background

The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) covers the entire area included in the Sacramento River and San Joaquin River drainage basins. These basins are bounded by the crests of the Sierra Nevada to the east, the Coast Range to the west, and the Klamath Mountains to the north and northwest. They extend some 400 miles from the California - Oregon border southward to the headwaters of the San Joaquin River. Surface waters from the two drainage basins meet and form the Delta, which ultimately drains to San Francisco Bay.

The preparation and adoption of a Basin Plan is required by California Water Code Section 13240. In California, a Basin Plan is the basis for regulatory actions that are to be taken for water quality control. The Basin Plan is also used to satisfy Section 303 of the federal Clean Water Act (CWA), which requires states to adopt water quality standards to meet federal regulatory requirements. Basin Plans are adopted and amended by the Regional Boards using a structured process involving full public participation and state environmental review. Under State law, a Basin Plan must consist of all of the following:

1. Beneficial uses to be protected;

2. Water quality objectives (which are essentially the same as "criteria" for purposes of the federal CWA); and

3. A program of implementation needed for achieving water quality objectives.

The Regional Water Quality Control Board - Central Valley Region (CVRWQCB) initially adopted a Basin Plan for the Sacramento River and San Joaquin River Basins in 1975. In 1988 the CVRWQCB adopted an amendment to the Basin Plan for regulation of agricultural subsurface drainage discharges from the Grassland Watershed of Merced and Fresno Counties. That amendment included site-specific molybdenum, boron, and selenium water quality objectives for the San Joaquin River, Mud Slough (north), and Salt Slough. Selenium objectives were also adopted for wetland water supplies. The water quality objectives varied depending on the location of the water body relative to the Merced River, based on the amount of assimilative capacity in the water bodies upstream and downstream of the Merced River. The San Joaquin River and its tributary sloughs upstream of the Merced River had less stringent objectives because the flow and quality of these waters are governed by agricultural irrigation and wetland return flows (effluent-dominated), while the objectives for the San Joaquin River downstream of the Merced River are more stringent because the natural flow of the San Joaquin River is dominated by the good quality inflows from eastside tributaries. A critically-dry year relaxation for boron and selenium also applied to the San Joaquin River downstream of the Merced River because natural flow from the eastside tributaries drops significantly during droughts.

The focus of the implementation plan adopted as part of the 1988 amendment was on drainage volume and pollutant load reductions through adoption of on-farm best management practices (BMPs), primarily water conservation. Progress toward meeting water quality objectives was to be documented in annual Drainage Operation Plans (DOPs), which would describe the progress individual water and drainage districts were making toward adoption of BMPs. Waste discharge requirements were to be considered only if water quality objectives were not met by the compliance dates. The CVRWQCB also adopted a prohibition against activities that would increase the discharge of poor quality agricultural subsurface drainage.

The State Water Resources Control Board approved the CVRWQCB's Basin Plan amendment in September 1989, but disapproved the proposed beneficial uses of Mud Slough (north) and Salt Slough. Following the State Board's action, the EPA disapproved many of the adopted objectives, including the selenium objective of 10 ug/L for the effluent-dominated water bodies upstream of the Merced River. These water bodies included Mud Slough (north), Salt Slough, and the San Joaquin River upstream of the Merced River. In addition, EPA disapproved the critically-dry year selenium objective of 8 ug/L for the San Joaquin River downstream of the Merced River. In 1990, the EPA approved the 5 ug/L monthly mean selenium objective in the San Joaquin River downstream of the Merced River, as well as the 2 ug/L monthly mean selenium objective for the water delivered to wetland areas within the Grassland watershed.

In December 1992, as part of a national rulemaking (the "National Toxics Rule"), the EPA promulgated a 5 ug/L, 4-day average chronic water quality criterion for selenium for all water bodies (except wetlands) covered by the 1988 CVRWQCB Basin Plan Amendment. This promulgation also superseded the 5 ug/L monthly mean selenium objective originally approved by the EPA for the San Joaquin River downstream of the Merced River. In December 1994, the CVRWQCB adopted a set of amendments to the Basin Plan that included deletion of all of the Plan's previous selenium water quality objectives that had been superseded by the EPA promulgation.[1]

The 1988 amendment was considered to be a first step in efforts to control agricultural subsurface drainage. Testimony received by the CVRWQCB in 1988 indicated that there was not a strong

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[1]EPA approved the Grassland Amendments in a May 24, 2000 letter to the State Water Resources Control Board subject to the results of consultation under section 7 of the ESA. Informal consultation with the Services regarding those amendments began several years ago, but was put on hold to allow resources to be devoted to consultation on EPA's upcoming promulgation of the CTR. The CTR was intended to fill a gap in California's water quality standards that was created when, pursuant to litigation by several municipalities and one industry, the State Water Resources Control Board was ordered to rescind two statewide water quality control plans that contained water quality criteria for priority toxic pollutants for which the State was required, under the CWA, to have criteria. In 1995, the CVRWQCB also amended the Basin Plan to specifically authorize the use of compliance schedules in National Pollutant Discharge Elimination System (NPDES) permits for achieving water quality objectives. The EPA took action on the 1996 Grassland Amendments, in advance of the 1994 and 1995 amendments, because of the importance of the Grassland Amendments in providing greater protection for threatened and endangered species.

understanding of the relationship between dilution flows and discharge, especially in the effluent-dominated water bodies receiving the drainage, and it was recognized that a revision to the Basin Plan's implementation plan for regulating agricultural subsurface drainage discharges would be needed as new information became available. The EPA's promulgation in 1992 of more stringent water quality criteria again raised a question regarding the adequacy of the previously adopted water quality objectives and the implementation plan outlined in the Basin Plan. Studies conducted for the CVRWQCB subsequently showed that the on-farm water conservation measures that had been emphasized in the1988 amendment as the primary method for meeting water quality objectives and reducing pollutant loads were not sufficient to meet water quality objectives for selenium in the sloughs and in the San Joaquin River downstream of the Merced River.

Grassland Amendments

The two Basin Plan amendments that are the subject of the February 8, 2000 request for formal consultation were adopted by the CVRWQCB in 1996, as part of a set of amendments that focused on the control of selenium-laden agriculture subsurface drainage discharges in and from the Grassland watershed. The need to reduce selenium loadings to, and concentrations in, the Grassland wetland water supplies and downstream waters in order to protect wildlife, including threatened and endangered species, was one of the driving forces behind the CVRWQCB's adoption of the Grassland Amendments. The Service has previously reviewed and commented on drafts of these amendments. The Grassland Amendments were adopted May 3, 1996 by the CVRWQCB via Regional Board Resolution 96-147, and approved by the State Water Resources Control Board in State Board Resolution 96-078 and by the State Office of Administrative Law on January 10, 1997.

Section 303(c) of the CWA (*i.e.*, the section addressing antidegradation, beneficial uses, water quality criteria, and implementation of water quality standards for surface waters) requires the EPA to approve or disapprove new or revised State-adopted water quality standards. On May 24, 2000 the EPA approved only those portions of the Grassland Amendments that are subject to the agency's water quality standards approval authority under Section 303(c). The EPA's approval is subject to the results of consultation(s) under section 7 of the ESA. This biological opinion serves as the Service's first formal section 7 consultation with the EPA on the Grassland Amendments. The two Grassland Amendments that are subject to this consultation are described below, excerpted directly from the EPA's biological evaluation. For citations in these excerpts, see Appendix A reference list.

First Subject Amendment

Basin Plan Chapter IV. IMPLEMENTATION, **Policies and Plans**

The "Policies and Plans" subsection was amended to reflect Regional Water Board Resolution No. 96-147, *San Joaquin River Agricultural Subsurface Drainage Policy*, by adding two statements[2]:

1. *Optimizing protection of beneficial uses on a watershed basis will guide the development of actions to regulate agricultural subsurface drainage discharges*;

   EPA's Action - EPA supports the watershed approach to water quality management, and intends to approve the addition of this policy statement, with the understanding that the water quality objectives for all water bodies within the watershed are effective immediately, even though not all water bodies within the watershed are expected to meet the applicable objectives immediately. In other words, although the watershed approach may drive the selection and timing of the Regional Board's actions in various water bodies, and some temporary degradation may occur in limited areas while efforts are focused on improving water quality in other areas, "optimizing protection of beneficial uses on a watershed basis" does not mean indefinitely sacrificing the quality of any one water body in order to improve or maintain the quality of other water bodies within (nor outside of) the watershed (CVRWQCB 1995).

2. *For regulation of selenium discharges, actions need to be focused on selenium load reductions.*

   EPA's Action - EPA agrees that selenium load reductions are needed for regulation of selenium discharges to be effective in achieving attainment of selenium objectives in the Grassland watershed and San Joaquin River, and intends to approve the addition of this policy statement.

Second Subject Amendment

Basin Plan Chapter IV. IMPLEMENTATION, Regional Water Board Prohibitions

The "*San Joaquin River Subsurface Agricultural Drainage*" subsection of the "Regional Water Board Prohibitions" section was amended to include prohibitions against the following:

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[2]In addition, a prohibition of activities that increase the discharge of poor quality agricultural subsurface drainage was deleted from this subsection; however, it was retained and re-stated in the **"Regional Water Board Prohibitions"** subsection. This was an editorial change intended simply to relocate the prohibition to a more appropriate section of the Basin Plan (Chilcott 1996).

2. Discharge of agricultural subsurface drainage water to Salt Slough and the identified wetland water supply channels after January 10, 1997, unless water quality objectives for selenium are being met.

This prohibition is intended to ensure that discharge of agricultural subsurface drainage water does not interfere with achievement of water quality objectives for selenium in Salt Slough and the wetland water supply channels after 1/10/97. If selenium objectives are not met, the prohibition requires the elimination of agricultural subsurface drainage flows to Salt Slough and the wetland channels. This is consistent with one of the Fish and Wildlife Service's priorities regarding agricultural drainage in the Grassland area, as stated in written comments to the Regional Board in 1995, i.e., "[r]emove agricultural drainage flows from over 90 miles of Grassland channels, including Salt Slough, so as to free them for delivery of freshwater to Refuges made available pursuant to the CVPIA" (Medlin 1995b).

A prohibition of agricultural subsurface drainage to Salt Slough and the wetland supply channels is expected to result (and, in fact, already has resulted) in diversion of such drainage to Mud Slough (north) via a portion of the San Luis Drain, a situation somewhat consistent with historical flow patterns in the Grassland watershed. Drainage has been discharged to Grassland watershed surface waters since 1950, when subsurface drainage systems were first installed in the drainage problem area. Prior to 1966, Mud Slough (north) drained the alluvial fan and the Basin rim physiographic zones, and, consequently, received all of the drainage from the drainage problem area. Salt Slough drained only the flood plain. In 1966, a diversion structure (City Gates Bypass) was constructed, which disrupted the natural drainage patterns by permitting the diversion of Basin rim and alluvial fan drainage to Salt Slough.

The year-round discharge of drainage to Mud Slough (north) can be expected to stabilize flow conditions in that Slough, which is subject to low flow conditions, especially during below-normal water years. The anticipated discharges to Mud Slough (north) are well within that body's historic flows, and are expected to be contained within the natural flow channels of the Slough; therefore, no significant increase in flooding nor impacts due to flooding are anticipated[3]. The water in Mud Slough, however, is already of poor quality, and the drainage likely to be diverted to it will, in the short-term, cause further water quality degradation in this Slough (CVRWQCB 1996).

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[3]In the first two years of operation of the Grassland Bypass Project, which was designed to re-route subsurface agricultural drainage around Salt Slough and the wetland water supply channels, via the San Luis Drain, into Mud Slough, extreme wet weather caused flows that exceeded the capacity of the Drain, with the result that some flows were diverted into Salt Slough and the wetland water supply channels. During the second year, drainers took precautions to minimize the comingling of drainage with the flood flows which were directed through some of the wetland supply channels and into Salt Slough. Project participants are working to better anticipate and manage future flood events in order to continue to reduce the risk of flood flows to the wetland supply channels and Salt Slough. In addition, funding from both CALFED and nonpoint source funds are supporting the development and implementation of Best Management Practices for the management of erosion and reduction of sediment and selenium load delivered from the upper watershed during high flow events.

If it stood alone, this prohibition could create the potential for increased discharges of selenium to the San Joaquin River; however, it will be implemented in tandem with other amendments to the Basin Plan, and an existing agreement, that, together, are expected to prevent any increase in selenium discharge to the River from occurring. There is evidence that suggests that when drainage water is transported through the wetland channels, up to 20% of the selenium in the drainage may be chemically transformed and immobilized in channel sediments or transferred to the wetlands and sequestered there. If drainage is diverted around the wetland channels, more of the selenium may be transported through to the River; however, due to the imposition of selenium load caps by a separate amendment to the Basin Plan (see section IV.E.4, below) and by the terms of the Agreement for Use of the San Luis Drain, this is considered unlikely. The Basin Plan amendment described in section IV.E.4, below, prohibits selenium loading from agricultural subsurface drainage systems in the Grassland watershed to the San Joaquin River in excess of 8000 lbs per year. This cap is based on historical selenium loads leaving the drainage problem area prior to movement through the wetland channels, and was recommended to the Regional Board by the U.S. Fish and Wildlife Service in written comments on the proposed amendments to the Implementation section of the Basin Plan (Medlin 1995b). The Use Agreement, signed by the Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority establishes an annual cap on selenium loading from the San Luis Drain to Mud Slough of 6660 lbs for the first two years of the diversion, with subsequent reductions of five percent per year through the end of the fifth year (US DOI 1995). The annual limits embodied in the Use Agreement were jointly recommended by the U.S. Fish and Wildlife Service, EPA, the Bureau of Reclamation, and the San Luis & Delta-Mendota Water Authority (Nelson, *et al.* 1995). Exceedance of these annual limits triggers the imposition of potential fines on the dischargers. Because of these caps on selenium loading, water quality in the San Joaquin River is not expected to be affected by the prohibition of discharge to Salt Slough and the wetland water supply channels.

A caveat allows the prohibition of drainage discharge to Salt Slough and the wetland channels to be reconsidered if public or private interests prevent the implementation of a separate conveyance facility for agricultural subsurface drainage. Any change to the prohibition as a result of such reconsideration would require another amendment to the Basin Plan, which would be subject to EPA approval or disapproval. Any EPA action on such an amendment would be subject to consultation with the Service under Section 7 of the Endangered Species Act.

EPA's Action - EPA intends to approve this amendment.

Compliance Schedule Amendment

In addition to the above two subject amendments, the Service also considered the effects of one of the related Grassland Amendments in developing this biological opinion. In Chapter IV of the Basin Plan, the "Actions and Schedule to Achieve Water Quality Objectives" section was amended to establish a compliance schedule for attainment of the chronic aquatic life selenium criterion established by the EPA under the National Toxics Rule (NTR). This compliance schedule would delay attainment of the selenium water quality objective in the San Joaquin River below the Merced River until October 2005 (above normal and wet water year types) and October 2010 (critical, dry, and below normal water year types). Attainment of the chronic selenium water quality objective in Mud Slough and in the San Joaquin River from Sack Dam to the Merced River would be delayed until October 2010 (Table 1).

Table 1. Compliance Time Schedule for Meeting the 4-day Average and Monthly Mean Water Quality Objective for Selenium[1].

Water Body/Water Year Type	1 Oct. 1996	1 Oct. 2002	1 Oct. 2005	1 Oct. 2010
Salt Slough and Wetland Water Supply Channels listed in Basin Plan Appendix 40	**2 ug/L monthly mean**			
San Joaquin River below the Merced River, Above Normal and Wet Water Year types		*5 ug/L monthly mean*	**5 ug/L 4-day average**	
San Joaquin River below the Merced River; Critical, Dry, and Below Normal Water Year types		*8 ug/L monthly mean*	*5 ug/L monthly mean*	**5 ug/L 4-day average**
Mud Slough (north) and the San Joaquin River from Sack Dam to the Merced River				**5 ug/l 4-day average**

[1] water quality objectives are shown in **bold** type; performance goals are shown in *italics*.

A detailed description of this amendment and the EPA's actions on the complete set of Grassland Amendments can be found in Appendix A

Description of Action Area

An action area is defined in 50 CFR 402.14(g)(3) as the immediate area involved in the action and the entire area where effects to listed species extend as a direct and indirect effect of the action. Two hydrologic areas are addressed in the Grassland Amendments. The first is the Grassland watershed, which is a valley floor sub-basin along the western side of the San Joaquin River from the Mendota Pool to the confluence with the Merced River. The second is the main stem of the San Joaquin River downstream of Sack Dam. The surface waters addressed in the Grassland Amendments are hydrologically connected to downstream surface waters (*i.e.*, the San Joaquin River downstream to and including the Sacramento-San Joaquin Delta Estuary and the San Francisco Bay). However, for the purposes of this biological opinion the action area analyzed is limited to the two defined hydrologic areas. This is because the primary effect of implementation of the Grassland Amendments is to redistribute selenium loading within the Grassland Watershed and is not expected to increase selenium loads in the San Joaquin River. Selenium loading from the Grassland Drainage Area and effects of interrelated actions on downstream sources were analyzed in the Grassland Bypass Project biological opinion, dated September 27, 2001 (File No. 1-1-01-F-0153).

Status of the Species (See Appendix B)

Environmental Baseline in the Action Area (See Appendix C)

Effects of the Proposed Action

EPA Determination of Effect on Listed Species

First Subject Amendment - In its biological evaluation, the EPA indicated that the CVRWQCB is likely to prioritize its actions to control selenium-contaminated subsurface agricultural drainage, focusing on certain geographic areas or types of measures sooner than others. Based on this assumption, the EPA concluded that adopting this watershed approach may result in temporary excursions of the NTR chronic selenium water quality criterion in limited areas of the watershed (*e.g.*, Mud Slough) while actions are being taken to improve the protection of beneficial uses in higher priority areas. In effect, the EPA concluded that some adverse effects on the giant garter snake may occur on a localized basis if the species inhabits an area of the watershed in which exceedances of the chronic selenium criterion are temporarily allowed.

Second Subject Amendment - The EPA concluded that prohibiting agricultural subsurface drainage into Salt Slough and the wetland supply channels, unless selenium water quality objectives are being met, would result in diversion of such drainage to Mud Slough (north) via a portion of the San Luis Drain. This diversion would temporarily degrade water quality in approximately nine miles of Mud Slough, potentially resulting in adverse impacts to giant garter snakes inhabiting the area from exposure to selenium-contaminated drain water.

Compliance Schedule Amendment - The EPA concluded that approval of this Grassland Amendment may affect, but is not likely to adversely affect the bald eagle, giant garter snake, Delta smelt, or Sacramento splittail. The EPA stated that the compliance schedule would bring about an improvement in water quality that will benefit listed species by driving the implementation of selenium control actions within defined periods of time and by providing milestones for evaluating progress. The Service agrees that the action of establishing performance goals and a compliance schedule to attain water quality objectives, by itself, would ultimately benefit listed species in the project area. However, it is the Service's biological opinion that the chronic selenium criterion promulgated in the 1992 NTR is unprotective and that adverse effects to listed species resulting from selenium discharges will not cease once compliance with the criterion is achieved. Therefore, Service concurrence with the EPA's 'not likely to adversely affect' determination for this amendment is predicated on fulfillment of the EPA's commitments and obligations from the CTR biological opinion involving the revision and promulgation of water quality criteria for selenium that are protective of listed species (for full discussion, see 'Conclusion' section of this biological opinion).

Service Determination of Effect on Listed Species

The Service concurs with the EPA's determination of 'likely to adversely affect' for the giant garter snake, which is based on delayed attainment of the selenium chronic aquatic life water quality objective in Mud Slough and the San Joaquin River. Further, based on the documented presence of the Sacramento splittail in Mud Slough, it is the Service's position that the proposed action also is likely to adversely affect this species.

As explained above, the current water quality objective for selenium in Mud Slough and the San Joaquin River is the chronic aquatic life criterion promulgated in the EPA's 1992 National Toxics Rule (5 ug/L, 4-day average). This is identical to the selenium criterion originally proposed by the EPA for the CTR. In the final biological opinion to the EPA on the effects of the CTR, issued on March 24, 2000 (Service File No. 1-1-98-F-21), the Service presented supporting documentation to show that this chronic selenium criterion would not be protective of listed species. This documentation, presented below, is used here to demonstrate that exceedances of the chronic selenium criterion in Mud Slough and the San Joaquin River resulting from implementation of the Grassland Amendments will likely adversely affect the giant garter snake and the Sacramento splittail.

Toxicity: For vertebrates, selenium is an essential micro-nutrient (Wilber 1980). Inadequate dietary uptake of selenium via food or water results in selenium deficiency syndromes such as reproductive impairment, poor body condition, and immune system dysfunction (Oldfield 1990; CAST 1994). However, excessive dietary uptake of selenium results in toxicity syndromes that are similar to the deficiency syndromes (Koller and Exon 1986). Thus, selenium is a "hormetic" chemical, i.e., one for which levels of safe dietary uptake are bounded on both sides by adverse-effects thresholds. Most essential nutrients are hormetic; what distinguishes selenium from other nutrients is the very narrow range between the deficiency threshold and the toxicity threshold (Wilber 1980; Sorensen 1991). Nutritionally adequate dietary uptake for vertebrates (from feed) is generally reported as 0.1 to 0.3 ug/g (ppm) on a dry feed basis. However, the toxicity dietary threshold for sensitive vertebrate animals is generally reported as 2 ug/g (ppm), only one order of magnitude above nutritionally adequate exposure levels (see review in Skorupa *et al.* 1996; USDI-BOR/FWS/GS/BIA 1998).

Margin-of-safety data suggest that environmental regulatory standards for selenium should generally be placed no higher than one order of magnitude above normal background levels (unless there are species-specific and site-specific data to justify a variance from the general rule). For freshwater ecosystems that are negligibly influenced by agricultural or industrial selenium contamination, normal background concentrations of selenium have been estimated as 0.25 ug/L (Wilber 1980), 0.1-0.3 ug/L (Lemly 1993a), 0.2 ug/L (Lillebo *et al.* 1988), and 0.1-0.4 ug/L (average <0.2, Maier and Knight 1994). These estimates suggest that the aquatic life chronic criterion for selenium of 2 ug/L would be most consistent with the central tendency value (0.2 ug/L) for normal background levels of waterborne selenium and a one order-of-magnitude margin of safety.

Direct Waterborne Contact Toxicity: Selenium occurs in natural waters primarily in two oxidation states, selenate (+6 oxidation state) and selenite (+4 oxidation state). Waters associated with various fossil-fuel extraction, refining, and waste disposal pathways contain selenium predominantly in the selenite (+4) oxidation state. Waters associated with irrigated agriculture in the western United States contain selenium predominantly in the selenate (+6) oxidation state. Based on traditional bioassay measures of toxicity (24- to 96-hour contact exposure to contaminated water without concomitant dietary exposure), selenite is more toxic than selenate to most aquatic taxa (see review in Moore *et al.* 1990).

However, direct contact exposure to selenium in water is only a minor exposure pathway for aquatic organisms (see review by Lemly 1996a). Most aquatic organisms are relatively insensitive to waterborne contact exposure to either dissolved selenate or dissolved selenite, with adverse-effects concentrations generally above 1,000 ug/L. By contrast, waterborne contact toxicity for selenium in the form of dissolved seleno-amino-acids (such as selenomethionine and selenocysteine) has been reported at concentrations as low as 3-4 ug/L for striped bass (*Morone saxitilis)* (Moore *et al.* 1990). It would be expected that at a chronic water standard of 5 ug/L total selenium the concentration of dissolved seleno-amino-acids would be substantially below 3-4 ug/L because seleno-amino-acids usually make up much less than 60-80 percent of total dissolved selenium in natural waters. For example, it was estimated that organo-selenium, including seleno-amino acids, made up only 4.5 percent of the total dissolved selenium in highly contaminated drainage water from the San Joaquin Valley (Besser *et al.* 1989).

Bioaccumulative Dietary Toxicity: Diet is the main pathway for toxicity of selenium to wildlife. Although typical concentrations of different chemical forms of selenium would be unlikely to cause direct contact toxicity at an aquatic life chronic standard of 5 ug/L, as little as 0.1 ug/L of dissolved selenomethionine has been found sufficient, via bioaccumulation, to cause an average concentration of 14.9 ug/g (dry weight) selenium in zooplankton (Besser *et al.* 1993), a concentration that would cause dietary toxicity to most species of fish (Lemly 1996a). Based on Besser *et al.*'s (1993) bioaccumulation factors (BAFs) for low concentrations of selenomethionine, as little as 0.006 ug/L of dissolved selenomethionine would be sufficient to cause foodchain bioaccumulation of selenium to concentrations exceeding toxic thresholds for dietary exposure of fish and wildlife. Thus, at a chronic aquatic life standard of 5 ug/L as total selenium, if more than 0.1 percent of the total dissolved selenium were in the form of selenomethionine, foodchain accumulation of selenium to levels sufficient to cause dietary toxicity in sensitive species of fish and birds would occur. For highly contaminated water (100-300 ug/L selenium) in the San Joaquin Valley, about 4.5 percent of all dissolved selenium was in the form of organo-selenium (Besser *et al.* 1989). Unfortunately, relative concentrations of seleno-amino-acids have not been determined in the field in California for waters where total selenium is found in the critical 1-5 ug/L range. Further research is required to characterize typical proportions of seleno-amino-acids in waters containing 1-5 ug/L total selenium.

Based on waters containing 1-5 ug/L total selenium, composite BAFs (defined as the total bioaccumulation of selenium from exposure to a composite mixture containing different selenium chemical forms and valence states, and measured only as total selenium) for aquatic foodchain items (algae, zooplankton, macroinvertebrates) are typically between 1,000 and 10,000 (on dry weight basis; Lillebo *et al.* 1988; Lemly 1996a). Therefore, based on risk from bioaccumulative dietary toxicity, a generic aquatic life chronic criterion provided in the absence of site-specific and species-specific toxicological data in the range of 0.2 to 2 ug/L would be justified. Based on an analysis of bioaccumulative dietary risk and a literature database, Lillebo *et al.* (1988) concluded that a chronic criterion of 0.9 ug/L for total selenium is required to protect fish from adverse toxic effects. Peterson and Nebeker (1992) applied a bioaccumulative risk analysis to semi-aquatic wildlife taxa and concluded that a chronic standard of 1 ug/L for total selenium was warranted. Most recently, Skorupa (1998) has compiled a summary of field data that includes multiple examples of fish and wildlife toxicity in nature at waterborne selenium concentrations below 5 ug/L, supporting the criteria recommendations of Lillebo *et al.* (1988) and Peterson and Nebeker (1992). Furthermore, a recently concluded regional survey of irrigation-related selenium mobilization in the western United States, conducted jointly by several agencies of the U.S. Department of the Interior over a ten-year period, found that at 5 ug/L total selenium in surface waters, about 60% of of avian eggs exceeded the toxic threshold for selenium, *i.e.*, that 5 ug/L selenium was only about 40% protective against excessive bioaccumulation of selenium into the eggs of waterbirds (Seiler and Skorupa, In Press).

Interaction Effects Enhancing Selenium Toxicity: Toxic thresholds for fish and wildlife dietary exposure to selenium have been identified primarily by means of controlled feeding experiments with captive animals (see reviews by NRC 1980, 1984, 1989; Heinz 1996; Lemly 1996a; Skorupa *et al.* 1996; USDI-BOR/FWS/GS/BIA 1998). Such experiments are carefully designed to isolate the toxic effects of selenium as a *solitary stressor*. Consequently, the toxic thresholds identified by such studies are prone to overestimating the levels of selenium exposure that can be tolerated without adverse effects in an environment with *multiple stressors*, as is typical of real world ecosystems (Cech *et al.* 1998). There are at least three well-known multiple-stressor scenarios for selenium that dictate a more conservative approach to setting water quality criteria for aquatic life:

1. *Winter Stress Syndrome* - More than 60 years ago it was first discovered in experiments with poultry housed in outdoor pens that dietary toxicity thresholds were lower for experiments done in the winter than at other times of the year (Tully and Franke 1935). More recently this was confirmed for mallard ducks (*Anas platyrhynchos*) by Heinz and Fitzgerald (1993). Lemly (1993b), studying fish, conducted the first experimental research taking into account the interactive effects of winter stress syndrome and confirmed that such effects are highly relevant even for waters containing <5 ug/L selenium. Consequently, Lemly (1996b) presents a general case for winter stress syndrome as a critical component of hazard assessments. It can be further generalized that any metabolic stressor (cold weather, migration, smoltification, pathogen exposure, etc.) would interact similarly to lower the toxic thresholds for dietary exposure to selenium. Based on a comparison of results from Heinz and Fitzgerald (1993) and Albers *et al.* (1996), the dietary toxicity threshold in the presence of winter stress was only half the threshold level for selenium as a solitary stressor. Thus, it appears that criteria based on single-stressor data should be reduced by at least a factor of two. The EPA's chronic criterion for selenium of 5 ug/L is based, in part, on field data from Belews Lake (U.S. Environmental Protection Agency 1987), presumably including multiple stressors as typically encountered in nature. However, as noted in a presentation by Dr. Dennis Lemly to the EPA Peer Consultation Committee on selenium (U.S. Environmental Protection Agency 1998), EPA's 5 ug/L criterion was based on the erroneous presumption that the Hwy. 158-Arm of Belews Lake was "unaffected." Dr. Lemly argues that multiple lines of evidence indicate adverse effects of selenium on fish in the Hwy. 158-

Arm of Belews Lake at concentrations of 0.2-4 ug/L. Dr. Lemly concludes that the true (multiple stressor) ". . . threshold for detrimental impacts [at Belews Lake] is well below 5 ug/L."

2. *Immune System Dysfunction* - Also more than 60 years ago, it was first noted that chickens exposed to elevated levels of dietary selenium were differentially susceptible to infection by pathogens (Tully and Franke 1935). More recently this was confirmed for mallard ducks by Whiteley and Yuill (1989). Numerous other studies have confirmed the physiological and pathological basis for selenium-induced immune system dysfunctions in wildlife (Fairbrother and Fowles 1990; Schamber *et al.* 1995; Albers *et al.* 1996). Based on Whiteley and Yuill's (1989) results, exposure of mallard ducklings to as little as 3.9 ug/g (dry weight basis) selenium in the egg (*in ovo*) was sufficient to significantly increase mortality when ducklings were challenged with a pathogen. The lowest confirmed *in ovo* toxicity threshold for selenium as a solitary stressor is 10 ug/g (dry weight basis; Heinz 1996, reported as 3 ug/g wet weight basis and about 70% moisture). In this case the multiple-stressor toxicity threshold was 2.56 times lower than the toxicity threshold level for selenium as a solitary stressor (10 ug/g ÷ 2.56 = 3.9 ug/g). Based in part on the solitary stressor toxic threshold reported by Heinz (1996) for mallard eggs, Adams *et al.* (1998) concluded that 6.77 ug/L selenium in water would be 90% protective against excessive bioaccumulation of selenium into avian eggs. Therefore based on a pathogen challenge multiple-stressor scenario, a 90% protective water quality criterion would be (6.77 ug/L) ÷ (2.56) = 2.64 ug/L. The multiple-stressor threshold would appear to be well below the proposed chronic criterion of 5 ug/L.

3. *Chemical Synergism* - Multiple stressors can also consist of exposure to other contaminants together with selenium.. Heinz and Hoffman (1998) recently reported very strong synergistic effects of dietary organo-selenium combined with organo-mercury on reproductive impairment of mallard ducks in the lab. The experiment of Heinz and Hoffman (1998) did not include selenium treatments near or below the threshold for diet-mediated reproductive toxicity and therefore no ratio of single-stressor versus multiple-stressor threshold levels is available. A field study involving 12 lakes in Sweden, however, found that in the presence of threshold levels of mercury contamination, the waterborne threshold for selenium toxicity was about 2.6 ug/L (see review in Skorupa 1998; and review in USDI-BOR/FWS/GS/BIA 1998). The Swedish lake study result is in agreement with multiple-stressor-derived criteria suggested above for winter stress and for pathogen challenge as multiple stressors. Based on the Swedish lakes study, which encompassed 98 different lakes, Lindqvist *et al.* (1991) concluded, "It is important not to dose so that selenium concentrations in water rise above about 1 to 2 μg Se/L." Likewise, Meili (1996) concluded that, "The results [of the Swedish Lakes studies] suggest that a selenium concentration of only 3 ug/L can seriously damage fish populations." At least one field study of birds also provides circumstantial evidence of lowered toxicity thresholds for selenium-induced reproductive impairment in the presence of mercury contamination (Henny and Herron 1989).

Environmental Partitioning and Waterborne Toxicity Thresholds: Risk management using water quality criteria based on water concentration alone is an inherently flawed process for selenium (Pease *et al.* 1992; Taylor *et al.* 1992, 1993; Canton 1997). The process is flawed because the true potential for toxic hazards to fish and wildlife is determined by the rate of mass loading of selenium into an aquatic ecosystem and the corresponding environmental partitioning of mass loads between the water column, sediments, and biota (food chain). Water concentrations of selenium are only a fraction of this interactive system determining risk. A water column concentration of selenium can be an imperfect and uncertain measure of mass loading and foodchain bioaccumulation. For example, a low concentration of waterborne selenium can occur because mass loading into the system is low (= low potential for hazard to fish and wildlife) or because there has been rapid biotic uptake and/or sediment deposition from elevated mass loading (= high potential for hazard to fish and wildlife).

Toxicity to fish and wildlife is ultimately determined by how much selenium is partitioned into the food chain. Therefore, water quality criteria are useful guides for risk management only to the extent that they protect aquatic food chains from excessive bioaccumulation of selenium. As evidenced by the literature cited above, a water quality chronic criterion of 2 ug/L is likely to protect aquatic food chains from excessive bioaccumulation under most permutations of environmental and human-caused factors (*i.e.*, the probability of adverse effects is sufficiently low). Nonetheless, several examples of potentially hazardous foodchain bioaccumulation of selenium at waterborne selenium concentrations <2 ug/L are known from California (Maier and Knight 1991; Pease *et al.* 1992; Luoma and Linville 1997; San Francisco Estuary Institute [SFEI] 1997a; Setmire *et al.* 1990, 1993; Bennett 1997) and elsewhere (Birkner 1978; Lemly 1997; Hamilton 1998). To substantively decrease the regulatory uncertainty of water quality criteria for selenium, ultimately a criterion-setting protocol will have to be formulated that links risk management and regulatory goals directly to aquatic food chain contamination (for example, see Taylor *et al.* 1992, 1993).

A variety of conceptual bases for deriving a generally applicable chronic water quality criterion for selenium that is protective of fish and wildlife have been presented above with the following results:

- Hormetic Margin of Safety Basis: 1-4 ug/L, with 2 ug/L being most consistent with central tendency data.

- Waterborne Exposure Only Basis: 3-4 ug/L for selenium in the form of seleno-amino-acids (e.g., selenomethionine); current EPA chronic criterion of 5 ug/L [is] adequate for selenium as inorganic ions (e.g., selenite and selenate).

- Bioaccumulative Dietary Exposure Basis (with Selenium as solitary stressor): 0.2-2.0 ug/L, with 0.9-1.0 ug/L supported by the two most detailed reviews to date.

- Winter Stress Syndrome Multiple Stressor Basis: ". . . well below . . . " 5 ug/L.

- Pathogen Challenge Multiple Stressor Basis: 2.6 ug/L.

- Mercury Synergism Multiple Stressor Basis: 2-3 ug/L.

The available body of scientific evidence (the majority of which has been produced subsequent to the EPA's 1987 criterion derivation for selenium) supports a chronic criterion of 2 ug/L for the protection of sensitive taxa of fish and wildlife. Even a criterion of 2 ug/L, however, can fail to be protective in specific cases where water column contamination with selenium fails to accurately reflect food chain contamination. There is a strong need for developing a method to link criteria directly to food chain contamination. In the absence of site-specific and species-specific data regarding the sensitivity of particular species and/or populations, a criterion of at most 2 ug/L is required to assure adequate protection of threatened and endangered species of fish and wildlife. This is especially warranted considering the steep response curves for selenium (Hoffman *et al.* 1996; Lemly 1998; Skorupa 1998) and the well-demonstrated potential for selenium-facilitated pathogen susceptibility that can rapidly extirpate entire populations of fish and wildlife via epizootic events.

Summary of the Effects to Listed Species

Giant Garter Snake

Selenium Toxicity to Giant Garter Snake: Toxicity information on reptiles is very limited. Studies on pine snakes (*Pituophis melanoleucus*) have shown that, unlike metals such as lead and mercury, selenium concentrations are greater in body tissue than in skin tissue (Burger, 1992). Endemic to wetlands in the Sacramento and San Joaquin Valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands (*e.g.*, irrigation and drainage canals, rice fields). Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941; Hansen 1980; Hansen 1988). These predatory foraging habits and habitat preference put the giant garter snake at risk of exposure to selenium that has bioaccumulated in the food chain.

Selenium is suspected as being a contributing factor in the decline of giant garter snake populations, particularly for the north and south Grassland sub-populations (*i.e.*, Kesterson National Wildlife Refuge complex) (USDI-FWS 1993). The remaining giant garter snake populations are more commonly found associated with waterbodies not impaired by selenium or other agricultural drainage contaminants (*e.g.*, Volta Wildlife Area and Los Banos Creek west of Kesterson National Wildlife Refuge). It is possible that elevated selenium levels in the San Joaquin Valley, resulting from contaminated agricultural drainage, contributed to the decline of the giant garter snake in the majority of this area. Whether selenium or other contamination may be responsible for the continued depression of giant garter snake population in otherwise apparently suitable habitats of the action area is not currently known.

As upper trophic level aquatic predators, giant garter snakes are at risk of exposure to elevated levels of bioaccumulative contaminants such as selenium. Over the life of the giant garter snake it is possible for snakes to accumulate contaminants that can impact the growth, behavior, survival, and reproduction of individuals, leading to declines in numbers and distribution. Water quality impairment of aquatic habitat that supports giant garter snakes could also reduce the prey base for the species.

The Department of the Interior's *Guidelines for the Interpretation of the Biological Effects of Selected Constituents in Biota, Water and Sediment* (USDI Guidelines) summarize background selenium levels in lizards, pine snake hatchlings from New Jersey (USDI-BOR/FWS/GS/BIA 1998), and snakes collected from the San Joaquin Valley. Alligator eggs from Florida suggest that reptile eggs are at the same selenium background level as fish and bird eggs (1-3 ppm). In the San Joaquin Valley, background levels of selenium in frog tissue range from 1.0 ppm to 3.6 ppm dry weight. Livers from gopher snakes in reference sites near Kesterson contained 1 - 4 ppm selenium. Skinless, whole-body pine snake hatchlings (considered representative of snake eggs) from New Jersey averaged 2.6 ppm. The USDI Guidelines state that it is probably safe to assume whole body concentrations at or above 10 times normal background (or ≥20 ppm) are toxic to populations of sensitive species (USDI-BOR/FWS/GS/BIA 1998). Further, the USDI Guidelines state that reproductive impairment is likely to be the most sensitive response and snake eggs with selenium concentrations ≥10 ppm are being reproductively impaired.

In the absence of a species specific selenium toxicity model for the giant garter snake the Service would recommend using an avian risk model for selenium based on the close phylogenetic relationship of birds to reptiles (e.g., Romer 1966; Porter 1972; Storer *et al.* 1972). Although giant garter snakes are live-bearing, newly born garter snakes have yolk sacs like other egg-laying species. Using such an avian risk model, the Service concluded in the draft California Toxics Rule biological opinion that a selenium criterion of 5 ppb in water would jeopardize the giant garter snake. The Service has stated that a 2 ppb (monthly mean) standard for wetland water supply channels in the Grasslands should be protective of giant garter snakes and their habitat. However, various results for water concentrations of selenium as low as 0.5 ppb suggest that bioaccumulation can sometimes result in problematic selenium levels in benthic organisms and fish (trout) even at selenium levels below 2 ppb in water (Saiki and Palawski 1990; Luoma and Presser 2000).

Sacramento Splittail

Selenium Toxicity to Fish: A large amount of research regarding toxic effects of selenium on fish has been conducted since the late 1970's. Summarizing studies of warm-water fish, Lemly (1996b) reported that growth was inhibited at whole-body tissue concentrations of 5 to 8 ug/g selenium or greater among juvenile and adult fathead minnows (*Pimephales promelas*). Several species of centrarchids (sunfish) exhibited physiologically important changes in blood parameters, tissue structure in major organs (ovary, kidney, liver, heart, gills), and organ weight-body weight relations when skeletal muscle tissue contained 8 to 36 ug/g selenium. Whole-body concentrations of only 4 to 6 ug/g were associated with mortality when juvenile bluegill (*Lepomis macrochirus*) were fed selenomethionine-spiked commercial diets in the laboratory. When bluegill eggs contained 12 to 55 ug/g selenium, transfer of the selenium to developing embryos during yolk-sac absorption resulted in edema, morphological deformities, and death prior to the swim-up stage. In a laboratory study of "winter stress syndrome," juvenile bluegill exposed to a diet containing 5.1 ug/g selenium and water containing 4.8 ug/L selenium exhibited blood changes and gill damage that reduced respiratory capacity while increasing respiratory demand and oxygen consumption. In combination with low water temperature (4 degrees centigrade) these effects caused reduced activity and feeding, depletion of 50 to 80 percent of body fats, and significant mortality within 60 days. Winter stress syndrome resulted in the death of about one-third of exposed fish at whole-body concentrations of 5 to 8 ug/g selenium.

Excessive environmental selenium weakens the immune defenses of fish and wildlife, and can also trigger pathogen and toxin challenges that would not otherwise have occurred (Tully and Franke 1935; Whiteley and Yuill 1989; Larsen *et al.* 1997; Wang *et al.* 1997). For example, a red tide flagellate (*Chattonella verruculosa*) that causes mortality of fish such as yellowtail, amberjack, red and black sea bream, has recently been discovered to require above-normal exposure to selenium (Imai *et al.* 1996). Only when selenium extracted from contaminated sediments is added to growth media can *C. verruculosa* sustain rapid growth (i.e., toxic blooms). The level of contamination required to sustain rapid growth is only about twice normal background. Potential effects of selenium-mediated vulnerability to non-chemical stressors must be considered when assessing the threats of exposure of splittail to selenium. Current artificial hydrological conditions and altered ecological conditions are subjecting splittail populations to levels of stress unprecedented in the species prior history, while exposing splittail to artificially elevated selenium concentrations. Each of these factors alone poses serious threats to splittail; together they may pose synergistic threats greater than the sum of the parts. Under current conditions of reduced population and range and environmental stress, splittail are vulnerable to major impacts from epidemic disease, contaminant spills, or other catastrophic events.

Lemly (1996b) reported that salmonids are very sensitive to selenium contamination and exhibit toxic symptoms even when tissue concentrations are quite low. Survival of juvenile rainbow trout (*Oncorhynchus mykiss*) was reduced when whole-body concentrations of selenium exceeded 5 ug/g (dry wt.). Smoltification and migration to seawater among juvenile chinook salmon (*Oncorhynchus tshawytscha*) were impaired when whole-body tissue concentrations reached about 20 ug/g. However, mortality among larvae, a more sensitive life stage, occurred when concentrations exceeded 5 ug/g. Whole-body concentrations of selenium in juvenile striped bass (*Morone saxitilis*) collected from areas in California impacted by irrigation drainage ranged from 5 to 8 ug/g.

Based upon a review of more than 100 scientific papers, Lemly (1996b) recommended the following toxic effects thresholds for freshwater and anadromous fish exposed to elevated concentrations of selenium: 4 ug/g whole body; 8 ug/g skinless fillets; 12 ug/g liver; and 10 ug/g ovary and eggs. He also recommended 3 ug/g (ppm) as the toxic threshold for selenium in aquatic food-chain organisms consumed by fish. Lemly reported that when waterborne concentrations of inorganic selenium (the predominant form in aquatic environments) are in the 7- to 10-ug/L (ppb) range, bioconcentration factors in phytoplankton are about 3,000. [In other words, 7 ppb selenium in water would be likely to bioaccumulate in phytoplankton (algae, diatoms) to concentrations of about 21 ppm, a clearly toxic dietary concentration.] Consequently, he concluded that patterns and magnitudes of bioaccumulation are similar enough among various aquatic systems that a common number, 2 ug/L (for filtered samples of water), could be given as a threshold for conditions "highly hazardous to the health and long-term survival of fish."

Lillebo *et al.* (1988) calculated that a selenium criterion of 0.9 ug/L waterborne selenium was necessary to adequately protect fish associated with the San Joaquin River system, including the southern Delta. Saiki and Palawski (1990) sampled juvenile striped bass in the San Joaquin River system including three sites in the San Francisco Bay estuary. Striped bass from the estuary contained up to 3.3 ug/g whole-body selenium, a value just below Lemly's 4 ug/g toxicity threshold (1996b), even though waterborne selenium typically averages <1 ug/L and has been measured no higher than 2.7 ug/L within the estuary (Pease *et al.* 1992). Striped bass collected from Mud Slough in 1986, when the annual median selenium concentration in water was 8 ug/L (CVRWQCB 1997), contained up to 7.9 ug/g whole-body selenium and averaged 6.9 ug/g whole-body selenium.

Based on the analyses presented above, the Service concludes that exceeding the selenium chronic criterion of 5 ug/L, 4-day average through implementation of the Grassland Amendments will adversely affect the giant garter snake and Sacramento splittail.

Attainment of Selenium Objectives in Grassland Amendment Compliance Schedules

On April 10, 1998 the Service issued a draft jeopardy biological opinion to the EPA on the CTR. As part of that draft opinion, the Service concluded that the 5 ug/L, 4-day average chronic selenium criterion proposed for California's surface waters would not be adequate to protect certain listed species, based on the evidence presented above. For the final biological opinion, the Service reached a 'no jeopardy' determination based on EPA commitments to modify several criteria, including selenium. The EPA has committed to revise both the acute and chronic selenium criteria to be protective of listed species in California; however, until a revised chronic criterion is promulgated, the CTR objective remains in effect for most of California's surface waters and the NTR objective remains in effect for Mud Slough and the San Joaquin River from Sack Dam to Vernalis.

While the actions taken in the Grassland Amendments are separate from either the CTR or NTR promulgation of the 5 ug/L, 4-day average selenium chronic criterion, they do establish compliance schedules to meet this criterion in Mud Slough and the San Joaquin River. Therefore, the EPA commitments and obligations from the CTR biological opinion to promulgate revised selenium criteria have a bearing on continued implementation of the Grassland Amendments. The Service anticipates that any revised selenium chronic criterion promulgated by the EPA will be more protective than the current CTR/NTR criterion of 5 ug/L, 4-day average, and should be protective of listed species in Mud Slough and the San Joaquin River. However, should the EPA fail to promulgate protective selenium criteria, attainment of the criterion established in the Grassland Amendments compliance schedules will continue to likely adversely affect listed species in those water bodies.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Cumulative effects for the giant garter snake and its designated critical habitat considered in this biological opinion include:

1. Water management such as diversions, levee maintenance, channel dredging, channel enlargement, flood control projects, installation of pumps, wells, and drains, non-Federal pumping plants associated with water management in the Sacramento-San Joaquin Delta, intrusion of brackish water, continuing or future non-Federal diversions of water, flood flow releases, and changes in water management;

2. Introduction of non-native fish, wildlife and plants, inbreeding of small populations, and genetic isolation;

3. Discharges into surface waters including point source discharges (permitted), non- point source runoff (e.g., mining runoff), runoff from high-density confined livestock production facilities, agricultural irrigation drainwater discharges (surface and subsurface), runoff from overgrazed rangelands, municipal stormwater runoff, and illegal, release of contaminated ballast and spills of oil and other pollutants into enclosed bays, non-permitted discharges;

4. Overutilization for scientific, commercial, and educational purposes;

5. Logging, wildland fire and land management practices including fluctuations in agricultural land crop production, plowing, discing, grubbing, improper rangeland management, timber harvest practices, irrigation canal clearance and maintenance activities, levee maintenance, permitted and non-permitted use and application of pesticides, herbicides, fungicides, rodenticides, fumigants, fertilizers and other soil/water amendments, urban development, urban refuse disposal, land conversions, illegal fill of wetlands and conversion and reclamation of wetland habitats; and

6. Recreational disturbances, vandalism, road kills, off-road vehicle use, chronic disturbance, noise, disturbances from domestic dogs and equestrian uses.

Cumulative effects on Sacramento splittail and its designated critical habitat within the aquatic ecosystems considered in this biological opinion include:

1. Water management such as diversions, levee maintenance, channel dredging, channel enlargement, flood control projects, drainage pumps, diversion pumps, siphons, non-Federal pumping plants associated with water management in the Sacramento-San Joaquin Delta, intrusion of brackish water, continuing or future non-Federal diversions of water, flood flow releases, and changes in water management;

2. Introduction of non-native fish, wildlife and plants, hybridization with non-native fishes, inbreeding of small populations, and genetic isolation;

3. Discharges into surface waters including point source discharges (permitted), non-point source runoff (e.g., mining runoff), runoff from high-density confined livestock production facilities, runoff from copper sulfate foot baths associated with dairy farms, agricultural irrigation drainwater discharges (surface and subsurface), runoff from overgrazed rangelands, municipal and industrial stormwater discharges (permitted and non-permitted), release of contaminated ballast and spills of oil and other pollutants into enclosed bays, and illegal, non-permitted discharges;

4. Overfishing and overutilization for scientific, commercial, and educational purposes;

5. Wildland fires and land management practices such as timber harvest practices and improper rangeland management resulting in sedimentation of surface waters; and application of pesticides, herbicides, fungicides,, fumigants, fertilizers and other soil/water amendments, urban development, and conversion and reclamation of wetland habitats;

6. Recreational disturbances including water sports, illegal fishing, and off-road vehicle use.

Conclusion

Findings of Not Likely to Jeopardize

After reviewing the current status of the giant garter snake and Sacramento splittail, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, the Service has concluded that EPA approval of the two specifically identified Grassland Amendments is likely to adversely affect the giant garter snake and Sacramento splittail, but will not result in a level of anticipated take that is likely to jeopardize their continued existence. No statutory critical habitat has been designated for these species, therefore none will be affected. The Service reached these conclusions based on the following assumptions:

1. The Grassland Amendments requiring EPA approval are implemented as described.

2. The EPA's future adjustment of the selenium criteria required by the terms and conditions of the final biological opinion on the California Toxics Rule will consider the bioaccumulative nature of selenium in aquatic systems, not just the waterborne toxicity, and will result in protective criteria. Thus, listed fish and wildlife species which are aquatic system foragers will be protected by the future criteria and the procedures for site specific adjustments.

3. The EPA will continue to obtain sufficient data upon which to base future analysis and revision of selenium criteria to protect listed species.

4. Adverse effects associated with the implementation of the Grassland Amendments will be minimized by enhanced CWA/ESA coordination, in accordance with the February 22, 2001 Memorandum of Agreement between the EPA and the Service.

5. All applicable commitments and non-discretionary terms and conditions in the California Toxics Rule Final Biological Opinion (Service File No. 1-1-98-F-21) are met (see below).

Applicable Commitments from the California Toxics Rule

These commitments were made in a December 16, 1999 letter from EPA to the Services to conclude formal consultation on the CTR. The modifications were incorporated by reference into section M of the preamble of the EPA's final promulgation of the CTR. The modifications regarding selenium are as follows:

I. EPA Modifications Addressing the Services' April 9, 1999 Draft Reasonable and Prudent Alternatives for Selenium:

A. EPA will reserve (not promulgate) the proposed acute aquatic life criterion for selenium in the final CTR.

B. EPA will revise its recommended 304(a) acute and chronic aquatic life criteria for selenium by January 2002. EPA will propose revised acute and chronic aquatic life criteria for selenium in California by January of 2003. EPA will work in close cooperation with the Services to evaluate the degree of protection afforded to listed species by the revisions to these criteria. EPA will solicit public comment on the proposed criteria as part of its rulemaking process, and will take into account all available information, including the information contained in the Services' Opinion, to ensure that the revised criteria will adequately protect federally listed species. If the revised criteria are less stringent than those proposed by the Services in the Opinion, EPA will provide the Services with a biological evaluation/assessment on the revised criteria by the time of the proposal to allow the Services to complete a biological opinion on the proposed selenium criteria before promulgating final criteria. EPA will provide the Services with updates regarding the status of EPA's revision of the criterion and any draft biological evaluation/assessment associated with the revision. EPA will promulgate final criteria as soon as possible, but no later than 18 months, after proposal. EPA will continue to consult, under Section 7 of ESA, with the Services on revisions to water quality standards contained in Basin Plans, submitted to EPA under CWA section 303, and affecting waters of California containing federally listed species and/or their habitats. EPA will annually submit to the Services a list of NPDES permits due for review to allow the Services to identify any potential for adverse effects on listed species and/or their habitats. EPA will coordinate with the Services on any permits that the Services identify as having potential for adverse effects on listed species and/or their habitat in accordance with procedures agreed to by the Agencies in the draft MOA published in the Federal Register at 64 Fed. Reg. 2755 (January 15, 1999) or any modifications to those procedures agreed to in a finalized MOA.

C. EPA will utilize existing information to identify water bodies impaired by selenium in the State of California. Impaired is defined as water bodies for which fish or waterfowl consumption advisories exist or where water quality criteria necessary to protect federally listed species are not met. Pursuant to Section 303(d) of the CWA, EPA will work, in cooperation with the Services, and the State of California to promote and develop strategies to identify sources of selenium contamination to the impaired water bodies where federally listed species exist, and use existing authorities and resources to identify, promote, and implement measures to reduce selenium loading into their habitat.

II. Other Actions

A. EPA will initiate a process to develop a national methodology to derive site-specific criteria to protect federally listed threatened and endangered species, including wildlife, in accordance with the draft MOA between EPA and the Services concerning section 7 consultations.

B. EPA will use existing information to identify water bodies impaired by mercury and selenium in the State of California. "Impaired" is defined as water bodies for which fish or waterfowl consumption advisories exist or where water quality criteria necessary to protect the above species are not met. Pursuant to Section 303(d) of the CWA, EPA will work with the State of California to promote and develop strategies to identify sources of selenium and mercury contamination to the impaired water bodies where federally listed species exist, and use existing authorities and resources to identify, promote, and implement measures to reduce selenium and/or mercury loading into their habitat (*e.g.*, San Joaquin River, Salton Sea, Cache Creek, Lake Nacimiento, Sacramento - San Joaquin Delta, *etc.*). EPA will work closely with the Services in developing individual Total Maximum Daily Loads (TMDLs) to avoid delays in completing these actions.

In their finalization of the biological opinion on the CTR, the Services formalized and refined the preceding agreements into non-discretionary terms and conditions presented in the "Incidental Take Statement" section of that opinion.

III. Status of CTR Biological Opinion Terms and Conditions

After discussions between EPA, Service, and NMFS staff on July 11, 2001, the EPA subsequently proposed certain changes to the terms and conditions outlined in the CTR final biological opinion. The proposed changes, which included revisions to the timeline for the development of new acute and chronic selenium criteria, were formally presented to the Service in the EPA's September 6, 2001 letter. In the proposed new selenium timeline, criteria revision would be completed by April 2003, criteria proposal would be completed by April 2004, and criteria promulgation would be completed no later than June 2005. In effect, the promulgation of new selenium aquatic life criteria would be delayed by one year from the original timeline.

In April 2002, EPA provided a draft national selenium criteria document for review. In a letter dated May 15, 2002, the Service stated that the fish tissue chronic criterion recommended in the draft would not be protective of listed species. At a July 23, 2002 meeting with Mr. Geoffrey Grubbs, EPA Directory of the Office of Science and Technology, the Service and EPA agreed to work together to develop California specific criteria to protect listed species. Subsequently, a Selenium Forum was held on September 23, 24, and 25, 2002, to identify an appropriate methodology to develop selenium criteria for California and to initiate a process to carry out this effort. This process will take 4 to 5 years with the formal proposal of selenium criteria occurring by March 2006 at the earliest.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the EPA so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The EPA has a continuing duty to regulate the activity covered by this incidental take statement. If the EPA (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

In order to monitor the impact of incidental take, the EPA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

Amount or Extent of Take

The Service anticipates that take of listed species in the form of kill, injury, and harm is likely to occur as a result of EPA approval of the Grassland Amendments. Approval of the Grassland Amendments will temporarily allow for exceedances of the chronic selenium criterion in Mud Slough and the San Joaquin River, in accordance with the Amendments' implementation schedule.

Therefore, the Service anticipates the following levels of take may occur as a result of EPA approval of the Grassland Amendments.

Giant Garter Snake - The Service expects that incidental take of giant garter snakes will be difficult to quantify for the following reasons: (1) the snakes are secretive and notoriously sensitive to human activities; (2) individual snakes are difficult to detect unless they are observed, undisturbed, at a distance; (3) there is a low likelihood of discovering sublethally or lethally affected individuals; (4) losses may be masked by seasonal or inter-annual fluctuation in numbers; and (5) studies to quantify selenium-induced contribution–such as altered development or reduced immune function–to impacts, such as mortality or lowered fecundity, are difficult. However, take of this species can be anticipated from degradation of water quality by contamination with selenium, which is likely through food chain contamination to cause reduced reproductive success, reduced growth, and in the extreme, deformities and mortality among juveniles and adults. For these reasons, the Service is estimating the level of take as harm, injury, or mortality of giant garter snakes using affected portions of the San Luis Drain and Mud Slough (north) and the San Joaquin River below Mud Slough, resulting from exposure to elevated selenium levels as allowed by the Compliance Time Schedule for meeting selenium water quality objectives (Table 1). For the San Joaquin River below the Merced River, the Compliance Time Schedule dates for full attainment are October 1,2005 (for 'Above Normal' and 'Wet' Water Year types) and October 1,2010 (for 'Critical', 'Dry', and 'Below Normal' Water Year types). For Mud Slough (north) and the San Joaquin River from Sack Dam to the Merced River, the date for full attainment is October 1,2010. No incidental take of giant garter snakes is authorized in Salt Slough, the wetland supply channels, or other action area waters, for exposure to selenium levels in excess of those allowed by the Compliance Time Schedule.

Sacramento splittail - The Service anticipates that incidental take of Sacramento splittail will be difficult to detect since: (1) the species is aquatic in nature and therefore difficult to observe, (2) there is a low likelihood of discovering sublethally or lethally affected individuals; (3) the species is small bodied and/or affected at an early life stage not likely to be detected; (4) losses may be masked by seasonal or inter-annual fluctuation in numbers or by other causes such as ocean conditions that lie outside the action area; and (5) studies to quantify selenium-induced contribution–such as altered development or reduced immune function–to impacts, such as failure to escape predators or lowered fecundity, are difficult. However, take of this species can be anticipated from degradation of water quality by contamination with selenium, which is likely through food chain contamination to cause reduced reproductive success, reduced growth, and in the extreme, deformities and mortality among juveniles and adults. For these reasons, the Service is estimating the level of take as harm, injury, or mortality of Sacramento splittail using affected portions of the San Luis Drain and Mud Slough (north) and the San Joaquin River below Mud Slough, resulting from exposure to elevated selenium levels as allowed by the Compliance Time Schedule for meeting selenium water quality objectives (Table 1) For the San Joaquin River, below the Merced River, the Compliance Time Schedule dates for full attainment are October 1,2005 (for 'Above Normal' and 'Wet' Water Year types) and October 1,2010 (for 'Critical', 'Dry', and 'Below Normal' Water Year types). For Mud Slough (north) and the San Joaquin River from Sack Dam to the Merced River, the date for full attainment is October 1,2010. No incidental take of Sacramento splittail is authorized in Salt Slough, the wetland supply channels, or other action area waters, for exposure to selenium levels in excess of those allowed by the Compliance Time Schedule.

Effect of the Take

In the accompanying biological opinion, the Service has determined that this level of anticipated take is not likely to result in jeopardy to the identified listed species or destruction or adverse modification of statutory critical habitat.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the impact of the EPA's approval and the State of California's subsequent implementation of the Grassland Amendments on the giant garter snake and Sacramento splittail.

> Minimize the impact of the incidental take on giant garter snake and Sacramento splittail from exposure to selenium discharges associated with implementation of the Grassland Amendments.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the EPA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. The EPA will adhere to the terms and conditions for selenium from the final biological opinion on the CTR, including any subsequent modifications mutually agreed upon by the EPA, NMFS, and the Service. These terms and conditions state that the EPA will specifically address aquatic and aquatic-dependent species in the future adjustment of the selenium criteria.

2. When the revised selenium criterion or criteria are proposed for adoption into the CTR, the EPA will alert both the State Water Resources Control Board and the Central Valley RWQCB in order to facilitate any further Basin Plan revisions necessary to ensure that federally listed species are afforded adequate protection. The EPA will include the Service on any related correspondence with the State and Regional Boards.

3. By approving the Grassland Amendments, including the Compliance Schedule amendment, the EPA is allowing for temporary excursions of the 5 ug/L, 4-day average national selenium chronic criterion in Mud Slough and the San Joaquin River, with the qualification that the compliance schedule "...simply provides outer bounds..." for full attainment of the selenium water quality objective in these waters. The EPA also states that the various actions outlined in the Compliance Schedule amendment "...describe appropriate means of implementing the

selenium objectives and monitoring and ensuring progress in accordance with the compliance schedule."

Any excursions of the selenium chronic criterion in these waters beyond the compliance schedule timeframes, except as may be permitted by regulatory grace periods for dischargers to come into compliance with any new selenium water quality objective, would result in unauthorized take of the listed species described in this opinion. In order to ensure that criterion excursions do not extend beyond the compliance schedule timeframes, the EPA must provide the Service with annual evaluations of progress toward full attainment of the 5 ug/L selenium objective. These evaluations should consider all available monitoring data, the effectiveness of ongoing control actions, and the status of any alternative options for removing selenium-laden agricultural drainage from Mud Slough and the San Joaquin River.

This term and condition is not intended simply to provide the Service with Central Valley RWQCB-required monitoring data on in-stream selenium concentrations. Rather, these evaluations should provide the EPA's interim conclusions on whether those elements of the Grassland Amendments designed to reduce the discharge of selenium-laden drainage will be sufficient to achieve full attainment of the 5 ug/L selenium criterion, or any new criteria promulgated by the EPA, by the dates delineated in the Compliance Time Schedule. If at any time the EPA concludes that the actions of the Grassland area dischargers and the regulatory oversight agencies are not on track to achieve full attainment of the selenium water quality objective, the EPA shall initiate discussions with the Central Valley RWQCB and the Service aimed at developing plans of action for achieving compliance.

4. One of the primary functions of the Grassland Amendments is to prevent adverse effects to wildlife resources in the Grassland area by reducing selenium-laden drainage in Salt Slough and the wetland supply channels. To accomplish this goal, the Grassland Amendments established a chronic selenium water quality objective for these waters that is more stringent than the national criterion (2 ug/L, monthly mean vs. 5 ug/L, 4-day average). As described in Appendix C of this opinion, the 2 ug/L objective has been exceeded on numerous occasions since implementation of the Grassland Amendments. To prevent any unauthorized take of the listed species considered in this opinion resulting from these exceedances, the EPA should work with the Central Valley RWQCB to identify all controllable sources of selenium that may be contributing to the observed exceedances and to assist in determining appropriate measures to prevent further exceedances. The EPA will include the Service in any discussions related to this issue and will, in writing, provide the Service with any findings or recommendations resulting from this effort. At a minimum, these written results should be provided to the Service on an annual basis, starting in 2003.

5. The EPA will recommend by the next triennial review that the Central Valley RWQCB revise Appendix 40 of the Basin Plan (Grassland Watershed Wetland Channels) to include the Mendota Pool and the Delta Mendota Canal upstream of Mendota Pool. These waterbodies, located within the Grassland watershed, are sources of water for the Grassland

wetland supply channels and may be contributing to documented exceedances of the 2 ug/L water quality objective.

6. To minimize the risk of take associated with uncertainties about the effects of the Grassland Amendments on listed species, to review the implications for Grassland area dischargers of any new selenium criteria promulgated pursuant to the CTR consultation, to allow an updated re-evaluation of Grassland Amendments effects based on ongoing research and monitoring, and to assist in agency-coordinated adaptive management of Grassland Amendments impacts; the EPA and the Service shall conduct a comprehensive synthesis and review of Grassland Amendments impacts to the listed species addressed in this opinion, to be completed during the calendar year in which EPA promulgates new selenium aquatic life criteria in California that are protective of listed species. If feasible and agreed upon by all relevant agencies, this comprehensive synthesis and review may be combined with the status review of the Grassland Bypass Project, scheduled for 2005. Within three months of this coordinated review, and by no later than March 31, 2006, the Service will make a written finding, based on this review, regarding whether reinitiation pursuant to 50 CFR 402.16 is needed.

Reporting Requirements

The EPA must provide the Service's Endangered Species Division and Environmental Contaminants Division with annual reports to describe the progress of implementation of all the commitments in the Terms and Conditions sections of this biological opinion. The first annual report is due September 2003.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the ESA, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

The Service recommends the following additional actions to promote the recovery of federally listed species and their habitats in the action area of the Grassland Amendments:

1. The EPA should quantify the toxic effects of selenium, alone and in combination with mercury, to listed reptiles and amphibians using appropriate surrogate species. Research should include the most toxic forms of selenium and mercury and include full life cycle exposure protocols including dietary routes of exposure and maternal transfer as a route of embryonic exposure.

2. The EPA should, in cooperation with the Service and USGS, conduct research on the toxic effects of selenium, alone and in combination with mercury, on the reproductive success of piscivorous birds, using appropriate surrogate species. Research should include the most toxic forms of selenium and mercury and include sensitive life stages and exposure protocols that include dietary routes of exposure to females and maternal transfer as a route of embryonic exposure

3. The EPA should, in cooperation with the State and other appropriate agencies, develop a selenium budget in the Grassland watershed by identifying and quantifying all sources of selenium loading into the watershed and the subsequent environmental fate of the pollutant.

4. The EPA should, in cooperation with other appropriate Federal and State agencies, support a land retirement program which targets lands, on a willing seller basis, that contribute significant selenium loads to the Grassland watershed, San Joaquin River, and the Sacramento-San Joaquin Delta estuary.

5. Copy NMFS on all appropriate correspondence to the Service regarding selenium, CTR, and State implementation of Sacramento-San Joaquin Basin Plan and amendments..

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, we request notification of the implementation of any conservation recommendations.

REINITIATION-CLOSING STATEMENT

This concludes formal consultation on the Grassland Amendments as outlined in your February 8, 2000 request for formal consultation and final Biological Evaluation regarding EPA approval of Grassland Amendments. As provided in 50 **CFR** 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease, pending reinitiation.

The Service looks forward to future coordination with the EPA on other Basin Plan amendments, State implementation of the CTR, approvals of State-approved waste discharge amendments, TMML's and TMDL's, and all other applicable State activities that implement the Clean Water Act and require EPA approval. If you have questions regarding this opinion, please contact Joy Winckel or David Wright at (916) 414-6650 of our Endangered Species Division, or Tom Maurer or Daniel Russell of our Environmental Contaminants Division at (916) 414- 6590.

Sincerely,

Cliff Nagano

fn Cay C. Goude
Acting Field Supervisor

cc:
USFWS, ARD-ES, Portland, OR
NMFS, Santa Rosa, CA
SWRCB, Sacramento, CA
CVRWQCB, Sacramento, CA

LITERATURE CITED

Adams, W.J., K.V. Brix, K.A. Cothern, L.M. Tear, R.D. Cardwell, A. Fairbrother, and J. Toll.1998. Assessment of selenium food chain transfer and critical exposure factors for avian wildlife species: need for site-specific data. Pp. 312-342 *in*: E.E. Little, B.M. Greenberg, and B.M. Greenberg A.J. DeLonay (eds.), Environmental Toxicology and Risk Assessment: Seventh Volume, ASTM STP 1333. American Society for Testing and Materials, West Conshohocken, Pennsylvania.

Albers, P.H., D.E. Green, and C.J. Sanderson. 1996. Diagnostic criteria for selenium toxicosis in aquatic birds: dietary exposure, tissue concentrations, and macroscopic effects. J. Wildl. Dis., 32:468-485.

Alpers, C.N. and M.P. Hunerlach. 2000. Mercury Contamination from Historic Gold Mining in California. U.S. Geological Survey Fact Sheet FS-061-00. Sacramento, California. 6 pp.

Bailey, H.C., S. Clark, J. Davis, and L. Wiborg. Unknown date. The Effects of Toxic Contaminants in Waters of the San Francisco Bay and Delta. Final Report prepared for the Bay/Delta Oversight Council. Dept. of Water Resources, Contract No. B-59645.

Bailey, H.C., D.J. Ostrach, and D.E. Hinton. 1991. Effect of Rice Irrigation Water in Colusa Basin Drain on Fertilization Success and Embryonic Development in Striped Bass. Contract No. 9-169-250-0 Draft Report to California State Water Resources Control Board. 31 p

Baker Matta, M., J. Linse, C. Cairncross, L. Francendese, and R.M. Kocan. 2001. Reproductive and transgenerational effects of methylmercury or Aroclor 1268 on *Fundulus heteroclitus*. Environ. Toxicol Chem. 20:327-335.

Beam, J., K. Cripe, and C. Fien. 1999. San Joaquin Valley Giant Garter Snake Project. Unpublished report, California Department of Fish and Game, Los Banos, California. 3 pp. and attachments.

Beckon, W.N., A. Gordus, and M. Eacock. in DRAFT 2002. Biological Effects, Chapter 7 in Grassland Bypass Project Annual Report 2000 - 2001. San Francisco Estuary Institute, for the Grassland Bypass Project Oversight Committee. Oakland, California.

Beckon, W.N., M. Dunne, and A. Holmes. 2001. Biological Effects, Chapter 7 in Grassland Bypass Project Annual Report 1999 - 2000. San Francisco Estuary Institute, for the Grassland Bypass Oversight Committee. Oakland, California.

Beckon, W.N., and M. Dunne. 2000. Biological Effects, Chapter 7 in Grassland Bypass Project Annual Report 1998-99. U. S. Bureau of Reclamation, Sacramento, California.

Beckon, W.N., M. Dunne, J.D. Henderson, J.P. Skorupa, S.E. Schwarzbach, and T.C. Maurer. 1999. Biological effects of the reopening of the San Luis Drain to carry subsurface irrigation drainwater, Chapter 6 in Grassland Bypass Project Annual Report October 1, 1997 through September 30, 1998. U.S. Bureau of Reclamation, Sacramento, California.

Bennett, J. 1997. Biological effects of selenium and other contaminants associated with irrigation drainage in the Salton Sea area, California, 1992-94. Report to the National Irrigation Water Quality Program, United States Department of Interior, Washington, D.C. (In Press)

Besser, J.M., T.J. Canfield, and T.W. LaPoint. 1993. Bioaccumulation of organic and inorganic selenium in a laboratory food chain. Environ. Toxicol. Chem., 12:57-72.

Besser, J.M., J.N. Huckins, E.E. Little, and T.W. La Point. 1989. Distribution and bioaccumulation of selenium in aquatic microcosms. Environ. Poll.,62:1-12.

Birkner, J.H. 1978. Selenium in aquatic organisms from seleniferous habitats. Ph.D. Dissertation. Colorado State University, Fort Collins, Colorado. 121 p.

Brode, J. 1988. Natural history of the giant garter snake (*Thamnophis couchii gigas*. *In* Proceedings of the conference on California herpetology, H.F. DeListe, P.R. Brown, B. Kaufman, and B.M. McGurty (editors).,(p. 25-28). Southwestern Herpetologists Society, Special Publ. No. 4.

Brode, J. and G. Hansen. 1992. Status and future management of the giant garter snake (*Thamnophis gigas*) within the southern American Basin, Sacramento and Sutter counties, California. California Department of Fish and Game, Inland Fisheries Division, January 1992.

Burger, J. 1992. Trace Element Levels in Pine Snake Hatchlings: Tissue and Temporal Differences. Arch Environ Contam Toxicol. 22:209-213.

Canton, S.P. 1997. Difficulties with traditional approaches in setting aquatic life water quality criteria for selenium. Abstract in: Understanding Selenium in the Aquatic Environment, Proceedings of a Symposium in Salt Lake City, Utah, March 6-7, 1997. Kennecott Utah Copper, Magna, Utah.

CAST (Council for Agricultural Science and Technology). 1994. Risk and benefits of selenium in agriculture. Issue Paper No. 3. Ames, Iowa.

Caywood, M.L. 1974. Contributions to the Life History of the Splittail *Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State University, Sacramento, California. 77 pp.

Cech, J.J., Jr., B.W. Wilson, and D.G. Crosby. 1998. Multiple Stresses in Ecosystems. Lewis Publishers, Boca Raton, Florida. 202 p.

CVRWQCB. 2000. Review of selenium concentrations in wetland water supply channels in the Grassland watershed. Staff Report, May 2000, California Regional Water Quality Control Board, Central Valley Region. Sacramento, California, 25 pp.

CVRWQCB. 1998. Agricultural drainage contribution to water quality in the Grassland watershed of western Merced County, California: October 1995 - September 1997. Staff Report, December 1998, California Regional Water Quality Control Board, Central Valley Region. Sacramento, California. 56 pp and appendices.

CVRWQCB. 1997. Compilation of electrical conductivity, boron, and selenium water quality data for the Grassland Watershed and San Joaquin River, May 1985-September 1995. Staff Report. California Regional Water Quality Control Board, Central Valley Region, Sacramento, California. 59 p.

CVRWQCB. 1996. Amendments to the water quality control plan for the Sacramento River and San Joaquin River Basins for the control of agricultural subsurface drainage discharges. Staff Report, March 1996, California Regional Water Quality Control Board, Central Valley Region. Sacramento, California. 192 p.

Daniels, R.A. and P.B. Moyle 1983. Life history of splittail (Cyprinidae: *Pogonichthys macrolepidotus*) in the Sacramento-San Joaquin estuary. Fishery Bulletin 84-3:647-654.

Dickert, C., S. Hammond, T. Lim, L. Moeckly, H. Shepley, and J. Sparks. 2002. San Joaquin Valley Giant Garter Snake Project 2001. California Department of Fish and Game and U.S. Geological Survey, Biological Resources Division. 14 pp.

DWR and USDI (Department of Water Resources and United States Department of Interior, Bureau of Reclamation, Mid-Pacific Region). 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. 230 pp.

Eisler, R. 1985. Selenium hazards to fish, wildlife, and invertebrates: a synoptic review. Contaminant Hazard Reviews Report No.5. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, Maryland.

Fairbrother, A., and J. Fowles. 1990. Subchronic effects of sodium selenite and selenomethionine on several immune functions in mallards. Arch. Environ. Contam. Toxicol., 19:836-844.

Fitch, H.S. 1941. Geographic variation in garter snakes of the genus *Thamnophis sirtalis* in the Pacific coast region of North America. American Midland Naturalist, 26:570-592.

Foe, C.G. 1995. Evaluation of the potential impact of contaminants on aquatic resources in the central valley and Sacramento-San Joaquin Delta Estuary. White paper for the Department of Water Resources from the California Regional Water Quality Control Board, Central Valley Region, Sacramento, California, 23pp.

Gill, G.A. 2000. Studies of flux from Delta sediments. Progress Report *in:* C. Foe (Ed.), An assessment of ecological and human health impact of mercury in the Bay-Delta watershed. Central Valley Regional Water Quality Control Board, Sacramento, California (November 2000).

Goodbred, S.L., R.J. Gilliom, T.S. Gross, N.P. Denslow, W.L. Bryant, and T.R. Schoeb. 1997. Reconnaissance of 17β-Estradiol, 11-Ketotestosterone, vitellogenin, and gonad histopathology in common carp of United States streams: potential for contaminant-induced endocrine disruption. Open File Report 96-627. U.S. Geological Survey, Sacramento, California. 34 pp. + appendices.

Hamilton, S.J. 1998. Selenium effects on endangered fish in the Colorado River Basin. Pp. 297-313 *in:* W.T. Frankenberger, Jr., and R.A. Engberg (eds.), Environmental Chemistry of Selenium. Marcel Dekker, Inc., New York, New York.

Hamilton, S.J., K.J.. Buhl, N.L. Faeber, R.H. Wiedmeyer, and F.A. Bullard. 1990. Toxicity of organic selenium in the diet to chinook salmon. Environ. Toxicolo. Chem. 9:347-358.

Hansen, R. W. 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Master of Arts thesis, California State University, Fresno, California, 78 pp.

Hansen, G. E. 1996. Status of the giant garter snake (*Thamnophis gigas*) in the San Joaquin Valley in 1995. Final report for Calif. Depart. Fish and Game Standard Agreement No. FG4052IF. Unpubl. 31 pp.

Hansen, G.E. 1988. Review of the status of the giant garter *snake (Thamnophis couchi gigas)* and its supporting habitat during 1986-87. Final report to California Department of Fish and Game, Contract C-2060. 31 pp.

Hansen, G.E. 1986. Status of the giant garter snake Thamnophis couchi gigas (Fitch. in the Southern Sacramento Valley During 1986. Final report for Calif. Depart. Fish and Game Standard Agreement No. C-1433. Unpubl. 31 pp.

Hansen, G.E. 1982. Status of the giant garter snake (*Thamnophis couchi gigas).* along portions of Laguna and Elk Grove creeks, Sacramento County, California. Report to Sacramento County Planning Dept. 15 p.

Hansen, G. E. and J. M. Brode. 1980. Status of the giant garter snake *Thamnophis couchi gigas* (Fitch). California Department of Fish and Game, Inland Fisheries Endangered Species Program Special Publication 80-5, 14 pp.

Hansen, R. W. and G. E. Hansen. 1990. *Thamnophis gigas* (giant garter snake) reproduction. Herpetological Review 21(4): 93-94.

Heinz, G.H. 1996. Selenium in birds. Pp. 453-464 *in* W.N. Beyer, G.H. Heinz, and A.W. Redmon, (eds.), Interpreting Environmental Contaminants in Animal Tissues. Lewis Publishers, Boca Raton, Florida.

Heinz, G.H., and D.J. Hoffman. 1998. Methylmercury chloride and selenomethionine interactions on health and reproduction in mallards. Environ. Toxicol. Chem. 17:139-145.

Heinz, G.H., and M.A. Fitzgerald. 1993. Overwinter survival of mallards fed selenium. Arch. Environ. Contam. Toxicol. 25:90-94.

Henny, C.J., and G.B. Herron. 1989. DDE, selenium, mercury, and white-faced ibis reproduction at Carson Lake, Nevada. J. Wildl. Manage., 53:1032-1045

Hinds, N.E.A. 1952. Evolution of the California landscape. Calif. Div. of Mines Bull. No. 158. 240 pp.

Hoffman, D.J., G.H. Heinz, L.J. LeCaptain, J.D. Eisemann, G.W. Pendleton. 1996. Toxicity and oxidative stress of different forms of organic selenium and dietary protein in mallard ducklings. Arch. *Environ. Contam. Toxicol.* 31:120-127.

Imai, I., S. Itakura, Y. Matsuyama, and M. Yamaguchi. 1996. Selenium requirement for growth of a novel red tide flagellate *Chattonella verruculosa* (Raphidophyceae) in culture.Fisheries Sci .62:834-835.

Jarvinen, A.W., and G.T. Ankley. 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. Society of Environmental Toxicology and Chemistry (SETAC) Press, Pensacola, Florida. 364 pp.

Jones and Stokes Assoc., Inc. 1993. Sutter Bypass fisheries technical memorandum II: Potential entrapment of juvenile chinook salmon in the proposed gravel mining pond. May 27, 1993 (JSA 91-272). Sacramento, California. Prepared for Teichert Aggregates, Sacramento, California. 31 pp + Appendix.

Koller, L.D., and J.H. Exon. 1986. The two faces of selenium -- deficiency and toxicity -- are similar in animals and man. Can. J. Vet. Res. 50:297-306.

Kuivila K.M., and C.G. Foe. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco Estuary, California. .Environ Toxicol And Chem, 14(7):1141-1150.

Larsen, C.T., F.W. Pierson, and W.B. Gross. 1977. Effect of dietary selenium on the response of stressed and unstressed chickens to *Escherichia coli* challenge and antigen.Biol. Trace. Elem.Res. 58:169-176.

Lemly, A.D. 1998. Pathology of selenium poisoning in fish. Pp. 281-296 in W.T. Frankenberger, Jr., and R.A. Engberg (eds.),Environmental Chemistry of Selenium. Marcel Dekker, New York. 713 p.

Lemly, A.D. 1997. Ecosystem recovery following selenium contamination in a freshwater reservoir. Ecotoxicology and Environmental Safety 36:275-281.

Lemly, A.D. 1996a. Assessing the toxic threat of selenium to fish and aquatic birds. Environ. Monit. Assess., 43:19-35.

Lemly, A.D. 1996b. Selenium in aquatic organisms. Pp.427-445 in: W.N. Beyer, G.H. Heinz, and A.W. Redmon, (eds.), Interpreting Environmental Contaminants in Animal Tissues. Lewis Publishers, Boca Raton, Florida.

Lemly, A.D. 1993a. Guidelines for evaluating selenium data from aquatic monitoring and assessment studies. Environ. Monitor. Assess. 28:83-100.

Lemly, A.D. 1993b. Metabolic stress during winter increases the toxicity of selenium to fish. Aquatic Toxicol., 27:133-158.

Lillebo, H.P., S. Shaner, D. Carlson, N. Richard, and P. DuBowy. 1988. Water quality criteria for selenium and other trace elements for protection of aquatic life and its uses in the San Joaquin Valley. SWRCB Order No. W.Q. 85-1 Technical Committee Report, Appendix D. California State Water Resources Control Board, Sacramento, California.

Lindqvist, O., K. Johansson, M. Aastrup, A. Andersson, L. Bringmark, G. Hovsenius, L. Hakanson, A. Iverfeldt, M. Meili, and B. Timm. 1991. Mercury in the Swedish environment: Recent research on causes, consequences and corrective methods. Water Air Soil Pollut. 55:1-251.

Luoma, S.N. and T.S. Presser. 2000. Forecasting Selenium Discharges to the San Francisco Bay-Delta Estuary: Ecological Effects of a Proposed San Luis drain Extension. U.S. Geological Survey Open File Report 00-416, Menlo Park, California.

Luoma, S.N., and R. Linville. 1997. A comparison of selenium and mercury concentrations in transplanted and resident bivalves from North San Francisco Bay. Pp. 160-170 in: 1995

Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute, Richmond, California.

Maier, K.J., C.R. Nelson, F.C. Bailey, S.J. Klaine, and A.W. Knight. 1998. The accumulation of selenium by the aquatic biota of a watershed treated with seleniferous fertilizer. Bulletin of Environmental Contamination and Toxicology 60: 409-416.

Maier, K.J. and A.W. Knight. 1994. Ecotoxicology of Selenium in Freshwater Systems. Reviews of Environmental Contamination and Toxicology 134:31-48.

Maier, K.J. and A.W. Knight. 1991. The accumulation of selenium in aquatic ecosystems of a watershed treated with seleniferous fertilizer. Draft Manuscript. Department of Land, Air, and Water Resources, University of California, Davis, California. 15 pp.

May, J.T., R.L. Hothem, C.N. Alpers, and M.A. Law. 2000. Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California. U.S. Geological Survey, Open File Report 00-367. Sacramento, California. 35 pp.

Meili, M. 1996. Dramatic effects of selenium addition to lakes on the mercury concentrations and the survival of fish. Fourth International Conference on Mercury as a Global Pollutant, August 4-8, 1996, Hamburg, Germany. Abstract Book, p. 26.

Messersmith, J.D. 1966. Fishes collected in Carquinez Straight in 1961-1962. Pages 57-62 *in*: D.W. Kelly, editor. Ecological Studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fisheries Bulletin 133.

Monroe, M.W. and J. Kelly 1992. State of the estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moore, S.B., J. Winckel, S.J. Detwiler, S.A. Klasing, P.A. Gaul, N.R. Kanim, B.E. Kesser, A.B. DeBevec, K. Beardsley, and L.K. Puckett. 1990. Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California. Two Volumes. San Joaquin Valley Drainage Program, Sacramento, California.

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley, California.

Moyle, P.B., R.D. Baxter, T. Sommer, T.C. Foin, and R.R. Abbott. 2001. In prep. Sacramento Splittail White Paper. Presented in Draft Form at the January 29, 2001, CALFED Splittail Science Conference. 42 pp.

Moyle, P.B. and R.M. Yoshiyama. 1992. Fishes, aquatic diversity management areas, and endangered species: A plan to protect California's native aquatic biota. Draft report prepared for California Policy Seminar, University of California, Berkeley, California. July 1992. 196 pp.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an estuary. Science 231:567-573.

NRC (National Research Council). 1989. Irrigation-Induced Water Quality Problems: What Can Be Learned From the San Joaquin Valley Experience. Committee on Irrigation-Induced Water Quality Problems, Water Science and Technology Board, Commission on Physical Sciences, Mathematics, and Resources, NRC. National Academy Press, Washington, DC.

NRC (National Research Council). 1984. Nutrient Requirements of Poultry. Eighth Revised Edition. Committee on Animal Nutrition, NRC. National Academy of Sciences, Washington, DC.

NRC (National Research Council). 1980. Mineral Tolerance of Domestic Animals. Committee on Animal Nutrition, NRC. National Academy of Sciences, Washington, DC.

Oldfield, J.E. 1990. Selenium: its uses in agriculture, nutrition and health, and environment. Special Publication. Selenium-Tellurium Development Association, Inc., Darien, Connecticut.

Patterson, S. 1999. Lake Apopka: an environmental tragedy. Florida Times-Union, February 27, 1999 issue. Jacksonville, Florida.

Pease, W., K. Taylor, J. Lacy, and M. Carlin. 1992. Derivation of site-specific water quality criteria for selenium in San Francisco Bay. Staff Report, California Regional Water Quality Control Board - San Francisco Bay Region, Oakland, California. 37 p.

Peterson, J.A. and A.V. Nebeker. 1992. Estimation of waterborne selenium concentrations that are toxicity thresholds for wildlife. Archives of Environmental Contamination and Toxicology, 23:154-162.

Porter, K.R. 1972. Herpetology W.B. Saunders Co., Philadelphia, Pennsylvania. 524 p.

Romer, A.S. 1966. Vertebrate Paleontology, 3rd ed. University of Chicago Press, Chicago, Illinois. 468 p.

Rossman, D.A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman and London.

Rossman, D. A. and G. R. Stewart. 1987. Taxonomic reevaluation of *Thamnophis couchi.* Occasional Papers of the Museum of Zoology, Louisiana State University, No. 63, 23 pp.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of U.S. Bureau of Fisheries 27(637):103-152.

Saiki, M.K. 1998. An ecological assessment of the Grassland Bypass Project on fishes inhabiting the Grassland Water District, California. Final Report, prepared for the U.S. Fish and Wildlife Service, Sacramento, California.

Saiki, M.K. 1986. Concentrations of selenium in aquatic food-chain organisms and fish exposed to agricultural tile drainage water. Pp. 25-33 *in* Selenium and Agricultural Drainage: Implication for San Francisco Bay and the California Environment (Selenium II). The Bay Institute of San Francisco, Tiburon, California.

Saiki, M.K., and D.U. Palawski. 1990. Selenium and other elements in juvenile striped bass from the San Joaquin Valley and San Francisco Estuary, California. Arch.Environ.Contam Toxicol., 19:717-730.

San Francisco Estuary Institute. 2002. Grassland Bypass Compliance Monitoring Program. http://www.sfei.org/grassland/reports/index.htm

San Francisco Estuary Institute. 1997. 1995 Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute, Richmond, California. 324 pp.

Schamber, R.A., E.L. Belden, and M.F. Raisbeck. 1995. Immunotoxicity of chronic selenium exposure. Pp. 384-393 *in* G.E. Schuman, and G.F. Vance, (eds.), Decades Later: A Time For Reassessment. Proceedings of the 12th Annual National Meeting, American Society of Surface Mining and Reclamation, Princeton, West Virginia.

Seiler, R.L., and J.P. Skorupa. In Press. Water quality constraints on irrigated agriculture. U.S. Department of Interior investigations of irrigation-induced contamination of water, sediment, and biota. Fact Sheet No. FS-000-97. U.S. Geological Survey, Carson City, Nevada.

Setmire, J.G., R.A. Schroeder, and J.N. Densmore. 1993. Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1988-90. Water-Resources Investigations Report 93-4014. U.S. Geological Survey, Sacramento, California.

Setmire, J.G., J.C. Wolfe, and R.K. Stroud. 1990. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources Investigations Report 89-4102. U.S. Geological Survey, Sacramento California.

Skorupa, J.P. 1998. Selenium poisoning of fish and wildlife in nature: Lessons from twelve real-world examples. Pp. 315-354 *in*: W.T. Frankenberger and R.A. Engberg (eds.), Environmental Chemistry of Selenium. Marcel Dekker, New York, New York.

Skorupa, J.P., S.P. Morman, and J.S. Sefchick-Edwards. 1996. Guidelines for interpreting selenium exposures of biota associated with nonmarine aquatic habitats. Report to U.S. Department of Interior, National Irrigation Water Quality Program. U.S. Fish and Wildlife Service, Sacramento, California. 74 p.

Slotton, D. G., T.H. Suchanek, and S.M. Ayers. 2000. CALFED-UC Davis Delta Mercury Study: Year 2 Findings. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Sorensen, E.M.B. 1991. Metal Poisoning in Fish. CRC Press, Boca Raton, FL.

State Water Resources Control Board. 2002. www.swrcb.ca.gov/rwqcb5/programs/agunit/bypass/menu1.htm

Storer, T.I., R.L. Usinger, R.C. Stebbins, and J.W. Nybakken. 1972. General Zoology, 5th ed. McGraw-Hill Inc., New York. 899 p.

Suchanek, T.H., D.G. Slotton, S. Ayers, and D.C. Nelson. Methyl mercury bioaccumulation in re-flooded wetlands in the San Francisco Bay-Delta ecosystem.. in CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Taylor, K., J. Lacy, and M. Carlin. 1993. Mass emissions reduction strategy for selenium. Supplemental Staff Report. Basin Planning and Protection Unit. California Regional Water Quality Control Board - San Francisco Bay Region, Oakland, CA. 61 p.

Taylor, K., W. Pease, J. Lacy, and M. Carlin. 1992. Mass emissions reduction strategy for selenium. Staff Report. Basin Planning and Protection Unit. California Regional Water Quality Control Board - San Francisco Bay Region, Oakland, CA. 53 p.

Tully, W.C., and K.W. Franke. 1935. A new toxicant occurring naturally in certain samples of plant foodstuffs. VI. A study of the effect of affected grains on growing chicks. Poult. Sci., 14:280-284.

Turner, J.L. and D.W. Kelley 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. Fish and Game Bull. 136.

USDI-BOR (U.S. Department of the Interior, Bureau of Reclamation). 2001. Unpublished data.

USDI-BOR/FWS/GS/BIA (U.S. Department of the Interior, Bureau of Reclamation/Fish and Wildlife Service/Geological Survey/Bureau of Indian Affairs). 1998. Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment. National Irrigation Water Quality Program Information Report No. 3. Bureau of Reclamation, Denver, CO. 198 p.

USDI-FWS (U.S. Department of the Interior, Fish and Wildlife Service). 2001. Lab results released from Lake Apopka wildlife death investigation. Press release, Southeast Region 4, Atlanta, Georgia. June 11, 2001.

USDI-FWS (U.S. Department of the Interior, Fish and Wildlife Service). 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, Oregon.

USDI-FWS (U.S. Department of the Interior, Fish and Wildlife Service). 1994. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. 34 pages, plus figures.

USDI-FWS (U.S. Department of the Interior, Fish and Wildlife Service). 1993. Endangered and threatened wildlife and plants; determination of threatened status for the giant garter snake. **Federal Register** 58:54053-54066.

U.S. Environmental Protection Agency. 1998. Report on the Peer Consultation Workshop on selenium aquatic toxicity and bioaccumulation. EPA-822-R-98-007, September, 1998. Office of Water, U.S. Environmental Protection Agency, Washington, DC. 59 p.

U.S. Environmental Protection Agency. 1987. Ambient water quality criteria for selenium – 1987. Office of Water Regulation and Standards, United States Environmental Protection Agency, Washington, D.C.

Wang, C., R.T. Lovell, and P.H. Klesius. 1997. Response to *Edwardsiella ictaluri* challenge by channel catfish fed organic and inorganic sources of selenium. J Aq Anim Health, 9:172-179.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 9.

Whiteley, P.L., and T.M. Yuill. 1989. Immune function and disease resistance of waterfowl using evaporation pond systems in the southern San Joaquin Valley, California, 1986-89. Final Report to the U.S. Fish and Wildlife Service, National Wildlife Health Research Center, Madison, WI. 202 p.

Wiener J.G., 1995. Bioaccumulation of Mercury in Fish. National Forum on Mercury in Fish. U.S. Environmental Protection Agency, Office of Water. June 1995. EPA 823-R-95-002.